US Army Corps
of Engineers
Hydrologic Engineering Center

Reservoir Management Decision Support System for the Connecticut River Watershed

Appendix A: Modeled Reservoirs for the Connecticut River Watershed Application of HEC-ResSim

August 2013

PR-88b

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	August 2013
2. REPORT TYPE	Project Report
3. DATES COVERED *(From - To)*	
4. TITLE AND SUBTITLE	Reservoir Management Decision Support System for the Connecticut River Watershed Appendix A: Reservoir Management Decision Support System for the Connecticut River Watershed
5a. CONTRACT NUMBER	
5b. GRANT NUMBER	
5c. PROGRAM ELEMENT NUMBER	
5d. PROJECT NUMBER	
5e. TASK NUMBER	
5F. WORK UNIT NUMBER	
6. AUTHOR(S)	David Julian, Woodrow Fields, Leila Ostadrahimi, John Hickey, Townshend Barker, Chris Hatfield
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	U.S. Army Corps of Engineers Institute for Water Resources Hydrologic Engineering Center (CEIWR-HEC) 609 Second Street Davis, CA 95616-4687
8. PERFORMING ORGANIZATION REPORT NUMBER	PR-88b
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	U.S. Army Corps of Engineers New England District 696 Virginia Road Concord, MA 01742
10. SPONSOR/ MONITOR'S ACRONYM(S)	
11. SPONSOR/ MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT	Distribution authorized to U.S. Government Agencies only.
13. SUPPLEMENTARY NOTES	

14. ABSTRACT

This report was developed by the US Army Corps of Engineers Hydrologic Engineering Center (CEIWR-HEC) with New England District (CENAE) for assisting in the development of a Decision Support System for the Connecticut River watershed. The Decision Support System uses HEC-ResSim, HEC-EFM, HEC-RAS and estimates of unimpaired stream flows prepared by the U.S. Geological Survey. The Decision Support System will be used to analyze reservoir operating scenarios for a variety of water management purposes, including environmental, hydropower, flood control, water supply, and recreational considerations. This appendix provides detailed information about the modeled reservoirs. The overall Decision Support System is documented in PR-88.

15. SUBJECT TERMS

Hydrology, Decision Support System, HEC-ResSim, watershed, river, Connecticut River, water management, streamflow, Reservoir System Simulation, model, reservoir operation, operation set, data

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON	19b. TELEPHONE NUMBER
U	U	U	UU	629		

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39-18

Appendix A: Modeled Reservoirs for the Connecticut River Watershed Application of HEC-ResSim

August 2013

Prepared for:
US Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

Prepared by:
US Army Corps of Engineers
Institute for Water Resources
Hydrologic Engineering Center
609 Second Street
Davis, CA 95616

(530) 756-1104
(530) 756-8250 FAX
www.hec.usace.army.mil

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Separate from the report for the Decision Support System of the Connecticut River watershed is this reservoir reference appendix document. It contains information about each reservoir modeled in the HEC-ResSim model. Information for each reservoir includes descriptions and sources of all physical and operational parameters in the model. This appendix is to serve as the reference guide in case changes to the model occur. It can also be used for setting up models at the sub-watershed and individual reservoir scale.

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Ball Mountain

I. Overview

Ball Mountain Dam is a dam in Jamaica, Windham County, Vermont, in the southeastern part of the state. It was constructed between 1957 and 1961 by the United States Army Corps of Engineers and is owned and operated by the Corps. It is primarily used for flood control but is also used for recreation.

Figure 1 shows the location of Ball Mountain Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Ball Mountain Dam.

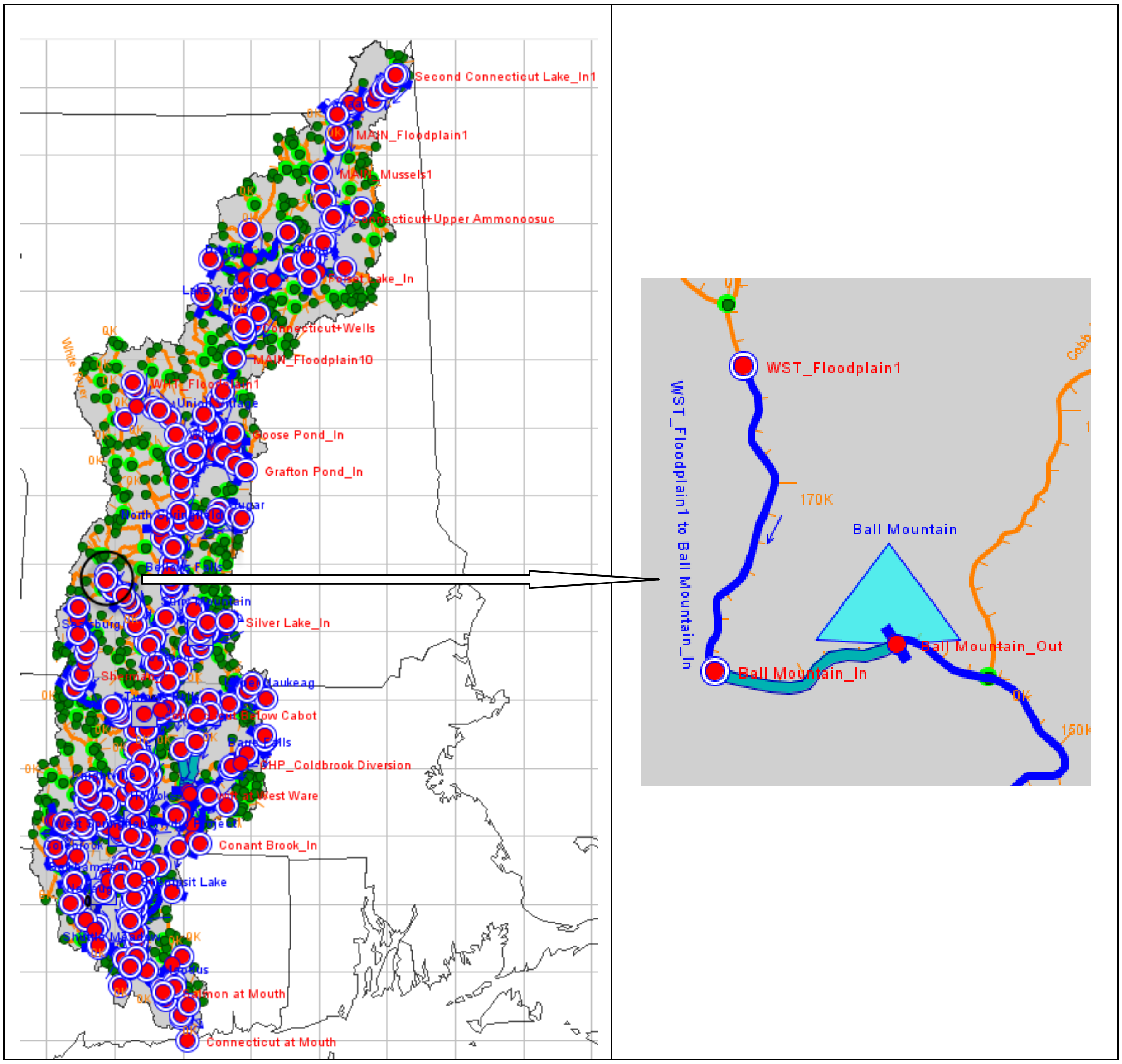


Figure 1: HEC-ResSim Map Display Showing Location of Ball Mountain dam

Figure 2: Photo of Ball Mountain Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled slide gates, and (2) uncontrolled outlet, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previous ResSim model and the Reservoir Regulation Team website[1].

[1] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

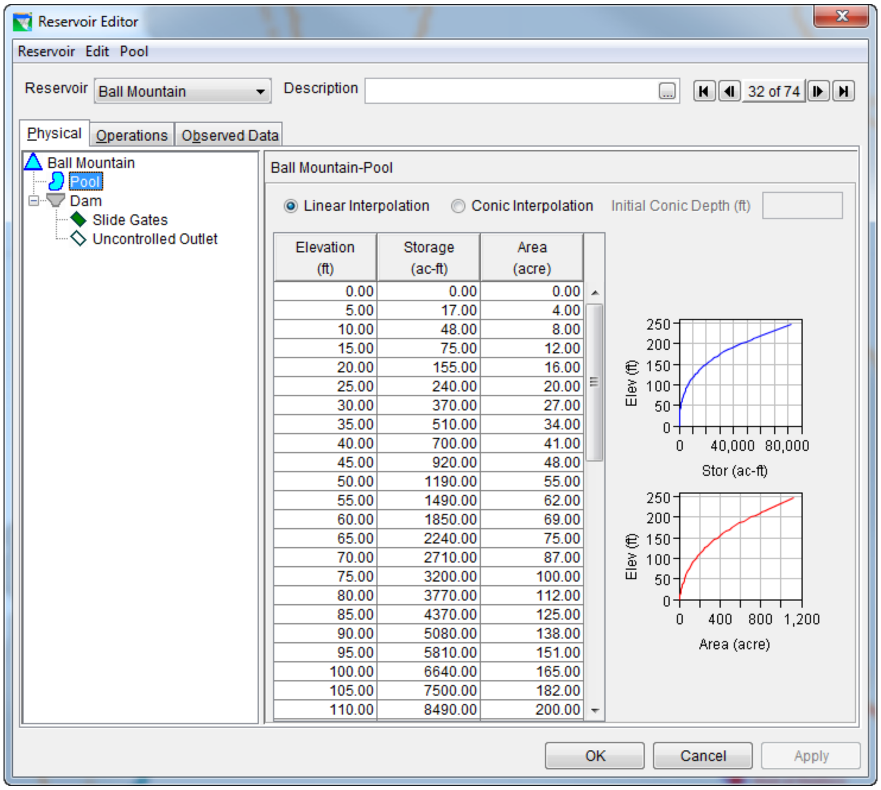


Figure 3: Reservoir Editor: Physical Tab -- Pool

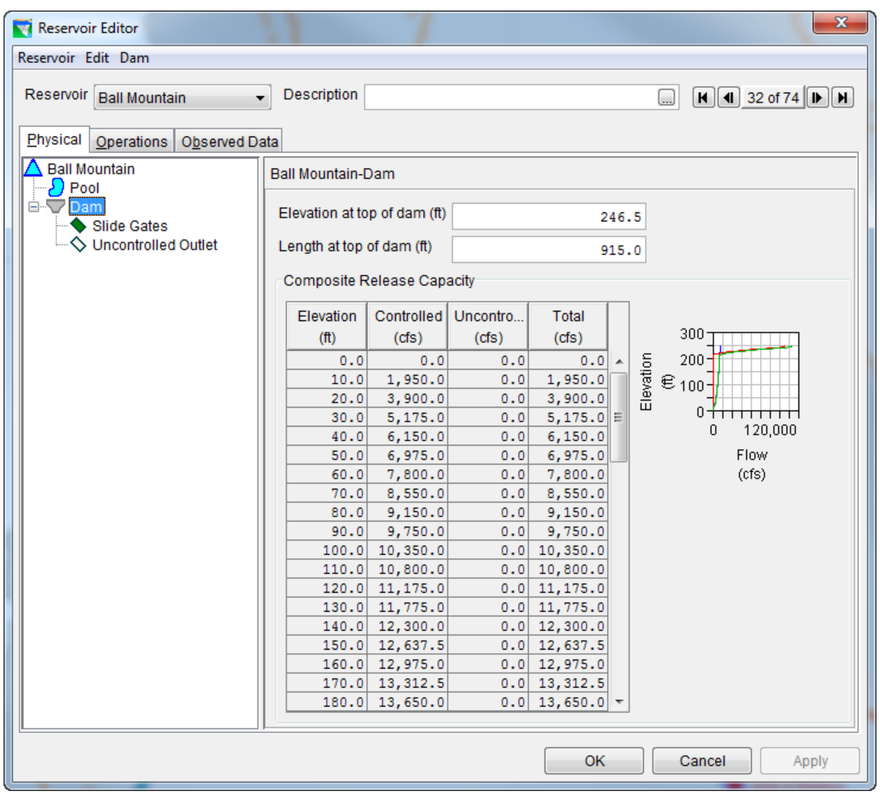


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Ball Mountain's "ExistingOps" operational zones, which consist of zones of Top of dam (246.5 ft), Surcharge (236.5 ft), Flood Control (211.5 ft), Conservation (25-65 ft), and Inactive zone (5 ft).

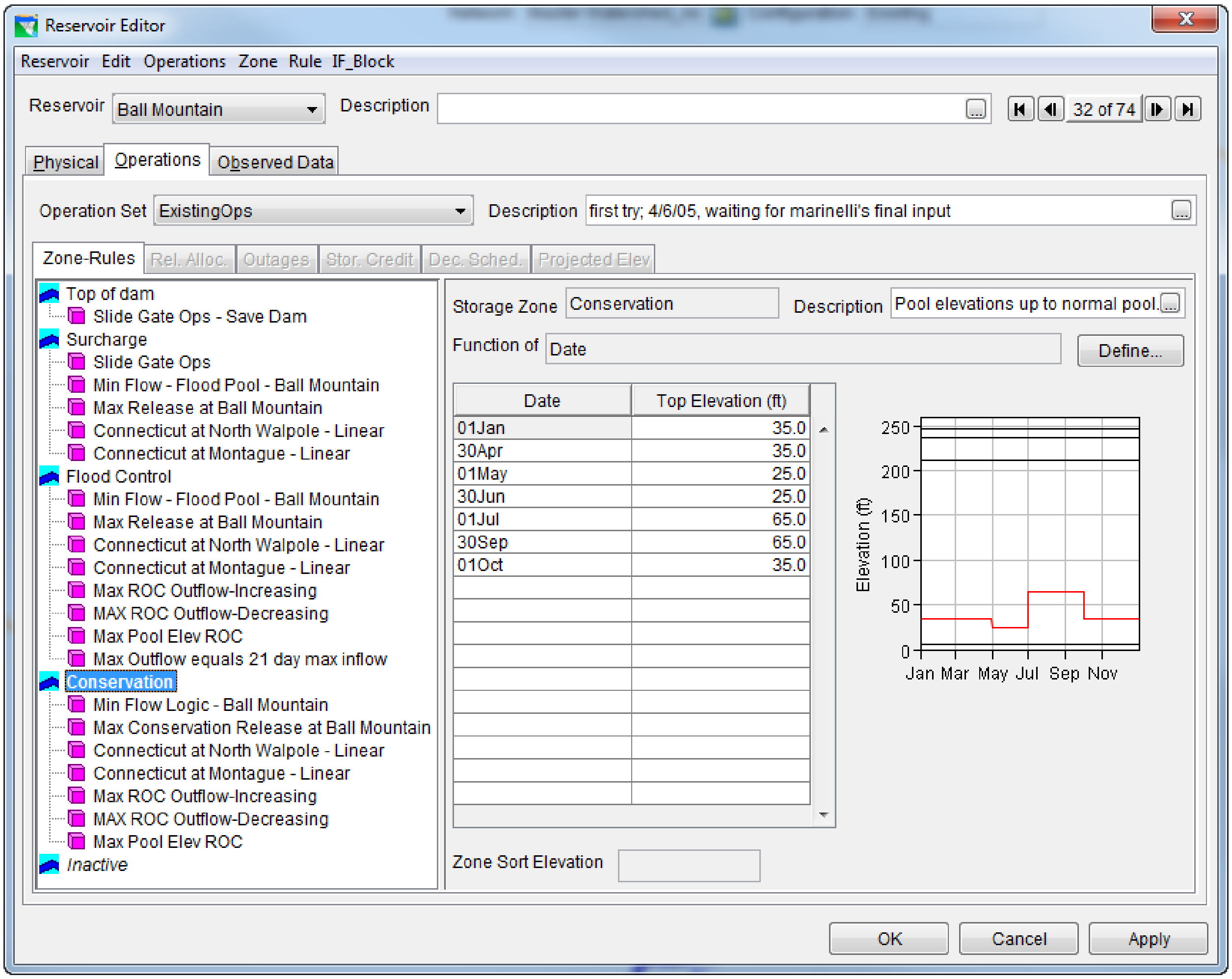


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

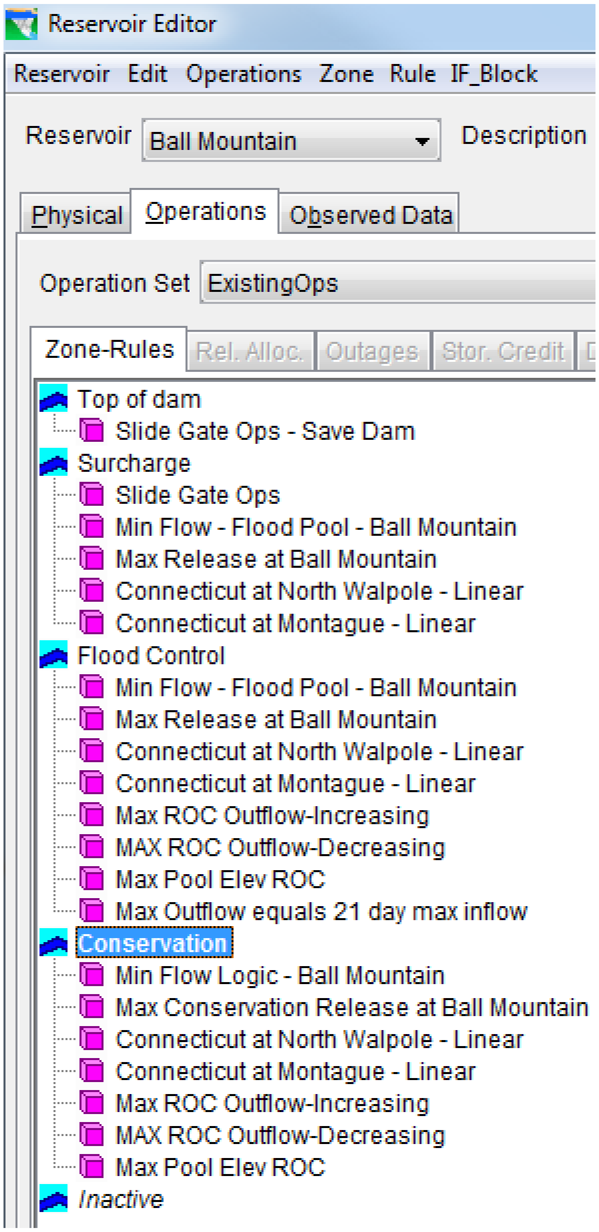


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Slide Gate Ops-Save Dam

Figure 7 shows the content of “Slide Gate Ops-Save Dam” rule. This rule represents the maximum allowable release from Slide gates when the pool is in Top of dam zone as a function of pool elevation.

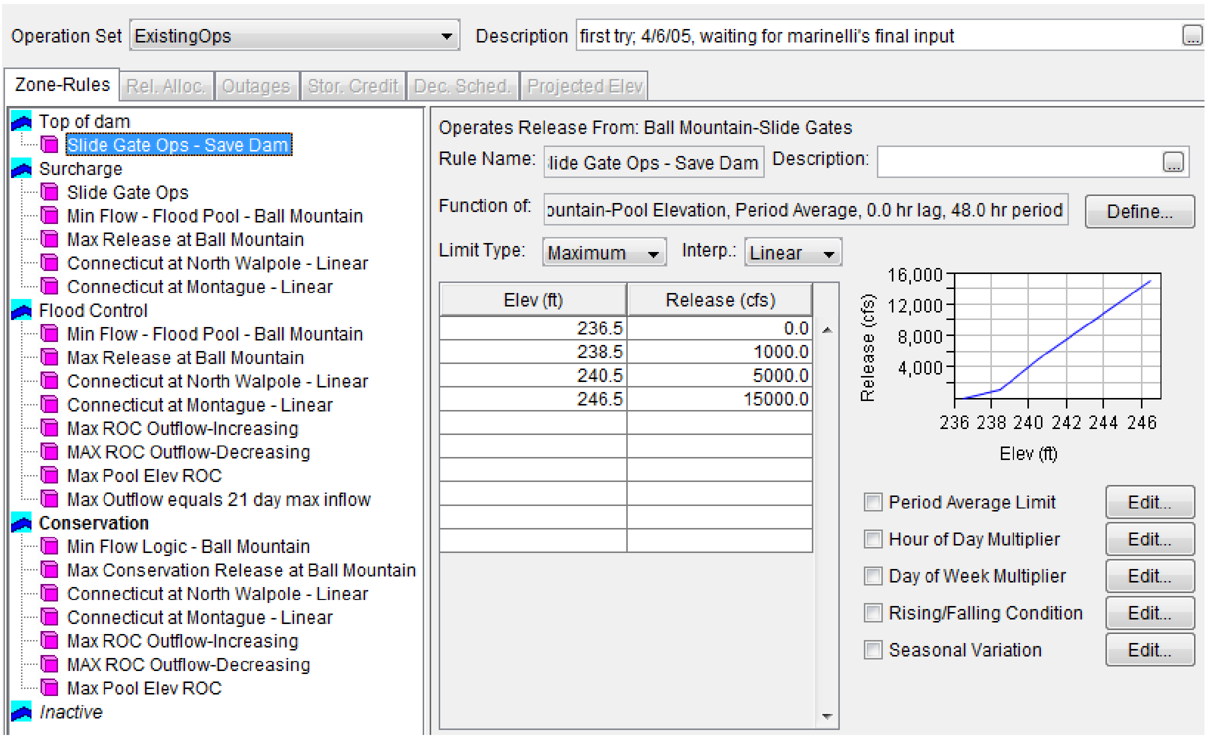


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Slide Gate Ops-Save Dam

2. Slide Gate Ops

Figure 8 shows the content of "Slide Gate Ops" rule. This rule represents the maximum allowable release from Slide gates as a function of pool elevation when pool is in surcharge zone.

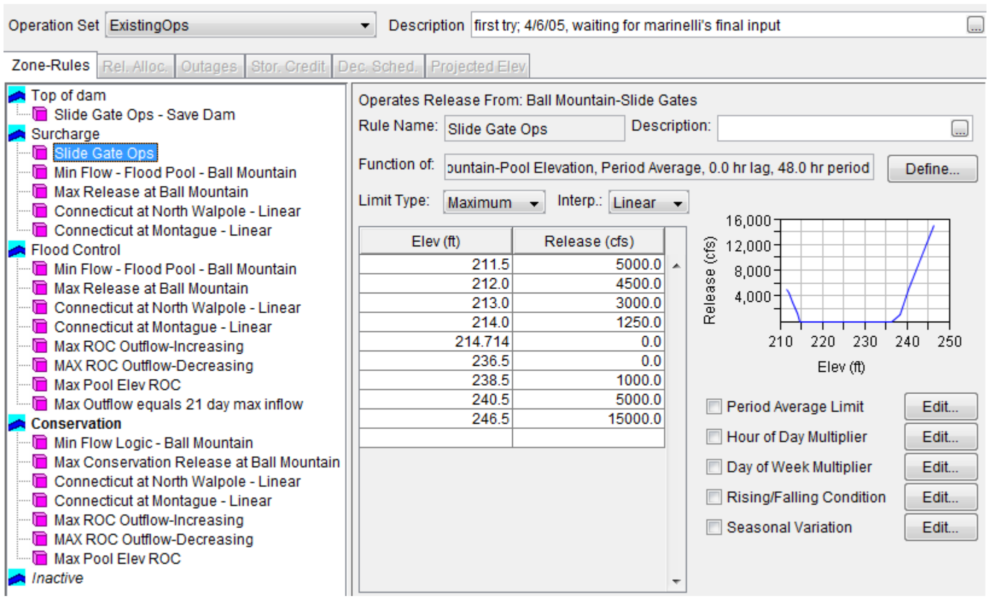


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Slide Gate Ops

3. *Min Flow-Flood Pool-Ball Mountain*

Figure 9 shows the content of "Min Flow-Flood Pool-Ball Mountain" rule. This rule shows the minimum allowable release from dam during flood control operations.

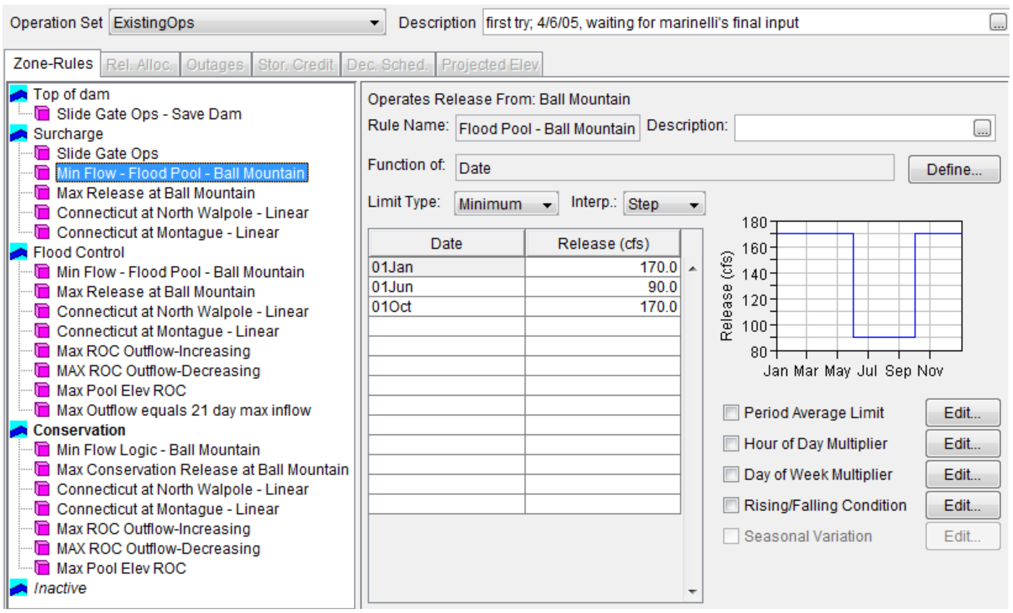


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min flow-Flood pool-Ball Mountain

4. *Max Release at Ball Mountain*

Figure 10 shows the content of "Max Release at Ball Mountain" rule. This rule assigns 5000 cfs as the maximum release from dam.

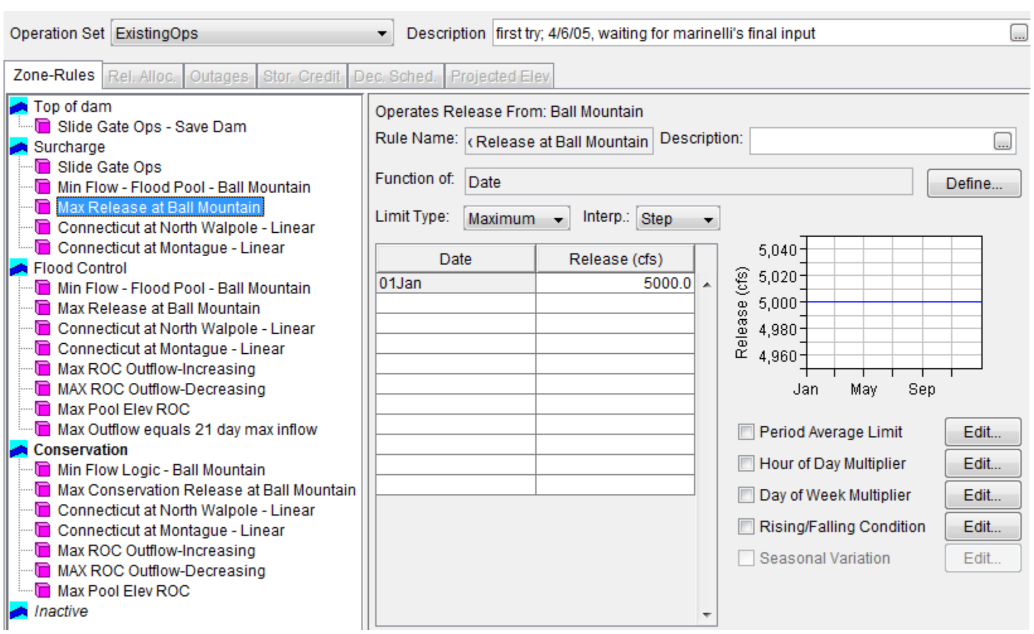


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Release at Ball Mountain

5. *Connecticut at North Walpole-Linear*

Figure 11 shows the content of "Connecticut at North Walpole-Linear" rule. This rule represents the maximum allowable release from dam as a function of previous day stage at North Walpole. The SOP for Ball Mountain was slightly different than the other flood control dams in that it called for an immediate reduction to 2000 cfs when a mainstem stage target was exceeded. Then the SOP says that the outflow will be directed by the Reservoir Regulation Team. The immediate reduction to 2000 cfs was accounted for in the rule and then 2000 cfs was used as the maximum when applying the linear release cutback described in the Simulation/Verification section of the report. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

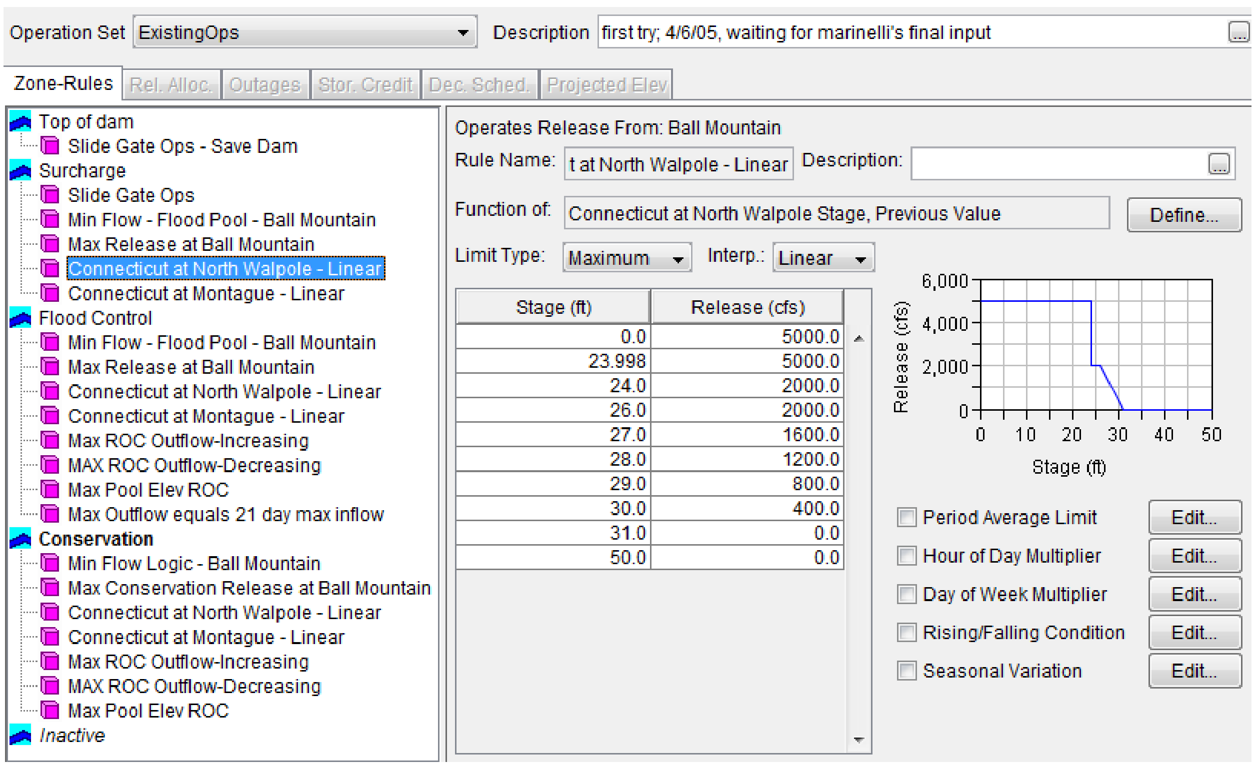


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at North Walpole-Linear

6. *Connecticut at Montague -Linear*

Figure 12 shows the content of "Connecticut at Montague-Linear" rule. This rule represents the maximum allowable release from dam as a function of previous day stage at Montague. The SOP for Ball Mountain was slightly different than the other flood control dams in that it called for an immediate reduction to 2000 cfs when a mainstem stage target was exceeded. Then the SOP says that the outflow will be directed by the Reservoir Regulation Team. The immediate reduction to 2000 cfs was accounted for in the rule and then 2000 cfs was used as the maximum when applying the linear release cutback described in the Simulation/Verification section of the report. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

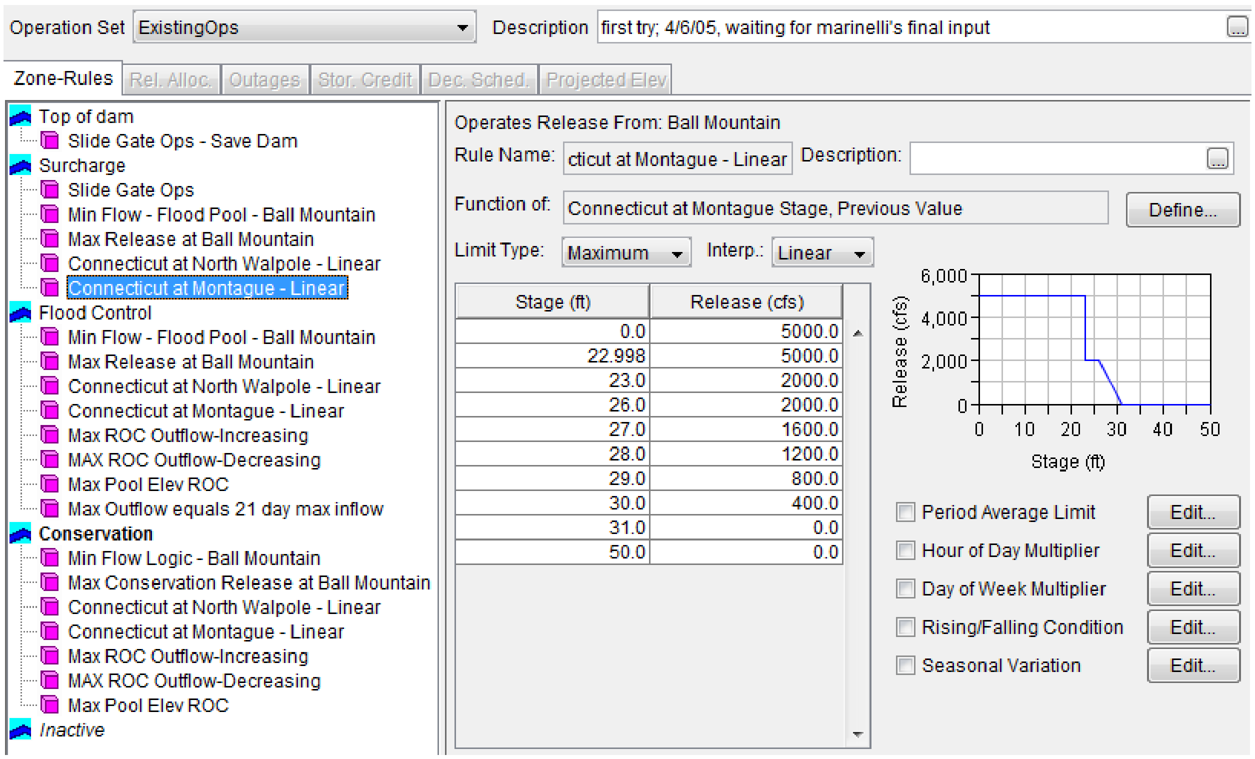


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague-Linear

7. *MAX ROC Outflow-Increasing*

Figure 13 shows the content of "MAX ROC Outflow-Increasing" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Ball Mountain dam.

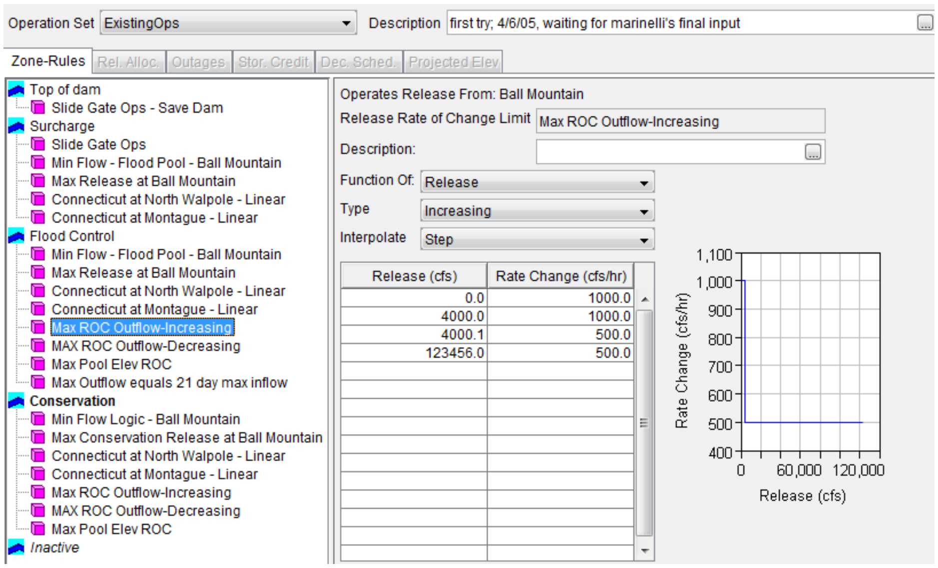


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – MAX ROC Outflow-Increasing

8. *MAX ROC Outflow-Decreasing*

Figure 14 shows the content of "MAX ROC Outflow-Decreasing" rule. This rule shows the maximum allowable decreasing release rate of change.

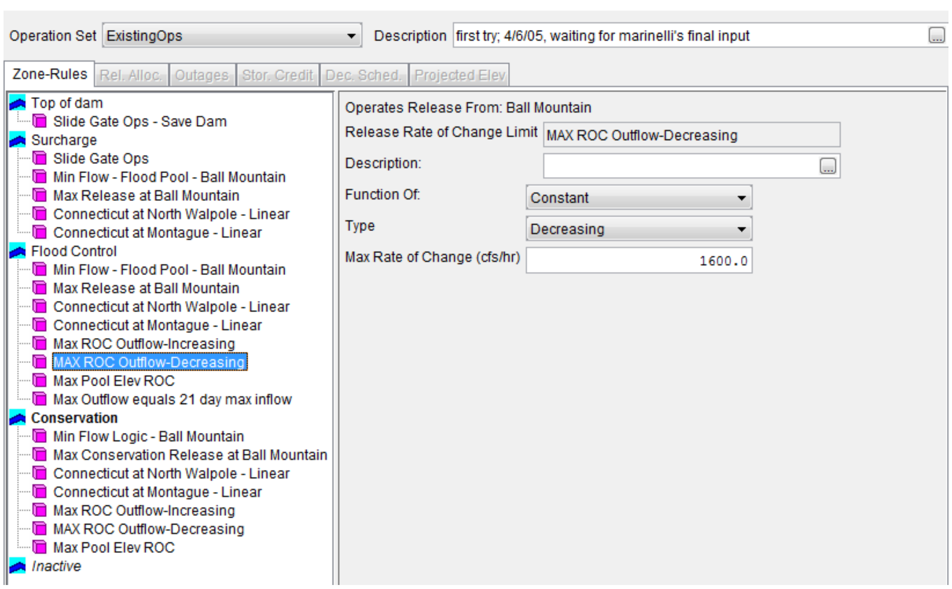


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet – MAX ROC Outflow-Decreasing

9. MAX Pool Elev ROC

Figure 15 shows the content of "MAX Pool Elev ROC" rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

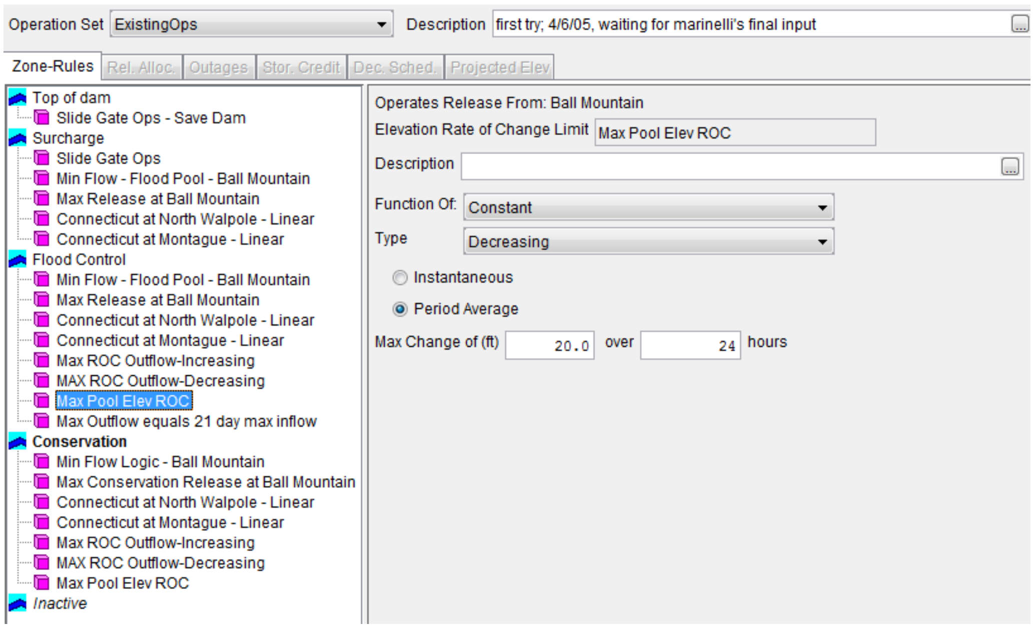


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet – MAX Pool Elev ROC

10. MAX Outflow equals 21 day max inflow

Figure 16 shows the content of "MAX outflow equals 21 day max inflow" rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

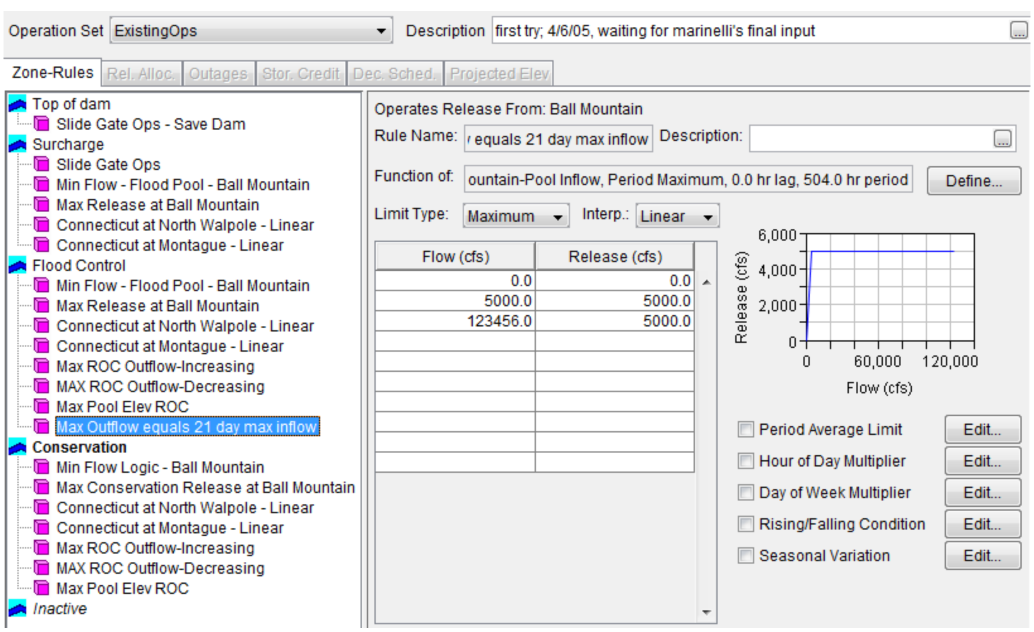


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet – MAX outflow equals 21 day max inflow

11. Min Flow Logic – Ball Mountain

Figure 17 shows the content of "Min Flow Logic – Ball Mountain" rule. This rule describes a seasonal minimum flow rule from the dam as a function of flow at Ball Mountain.

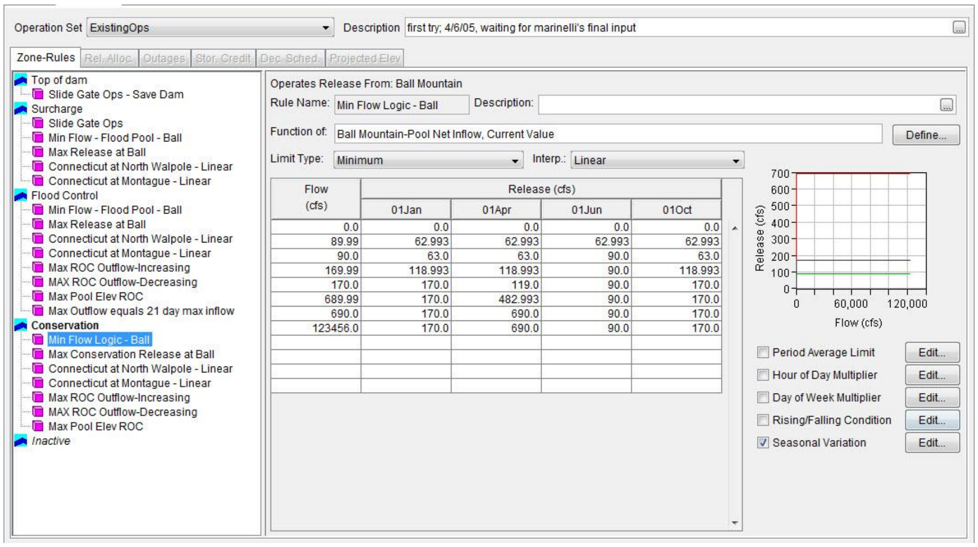


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic – Ball Mountain

12. Max Conservation Release at Ball

Figure 18 shows the content of "Max Conservation Release at Ball" rule. This rule represents the maximum allowable release from Ball Mountain when the pool is in the conservation zone. This rule is unique to Ball Mountain and Townshend.

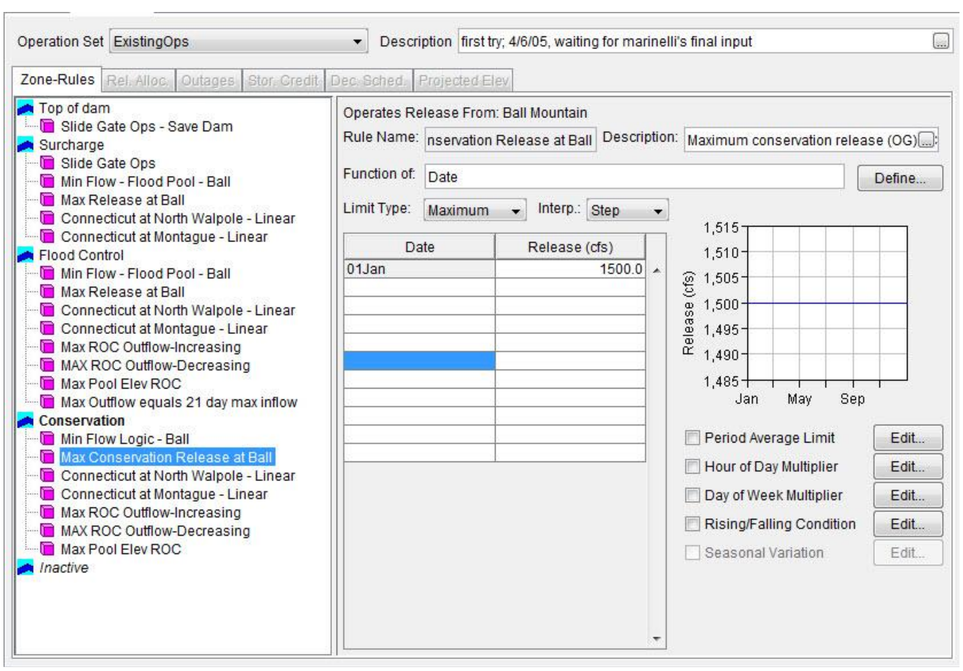


Figure 18: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Conservation Release at Ball

Barkhamsted

I. Overview

Construction of Barkhamsted Reservoir and Saville Dam were completed in 1940. It is owned and operated by the Hartford Metropolitan District Commission(MDC) and serves as the principal drinking water source for the city of Hartford, CT.

Figure 1 shows the location of Saville Dam and Barkhamsted reservoir as it is represented in the HEC-ResSim model, and Figure 2 shows a view from Saville Dam.

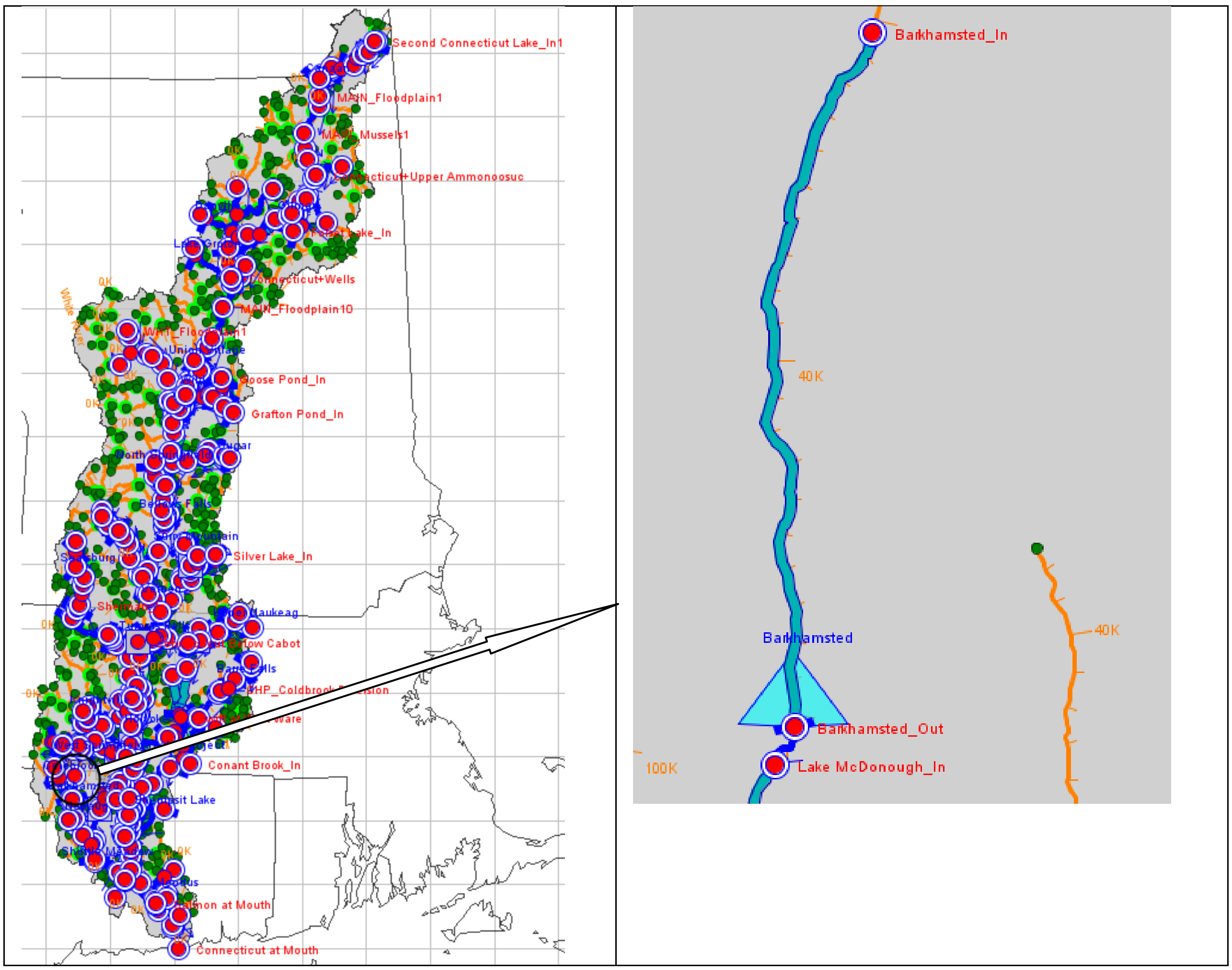


Figure 1: HEC-ResSim Map Display Showing Location of Barkhamsted reservoir

Figure 2: Photo of Barkhamsted reservoir

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[2]. The dam consists of one controlled spillway as shown in Figure 4[3].

[2] The Metropolitan District Hartford County, Conn. Barkhamsted Reservoir Available Capacity in Million Gallons. 1999.
[3] Adamec, K. Farmington Model Documentation. University of Massachusetts, 2009.

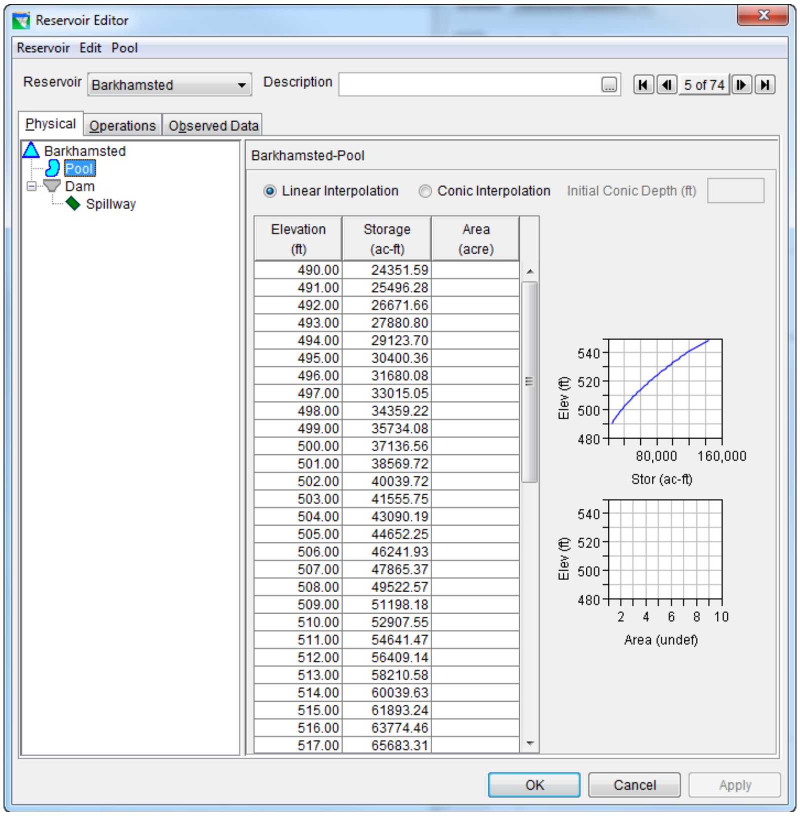


Figure 3: Reservoir Editor -- Physical Tab -- Pool

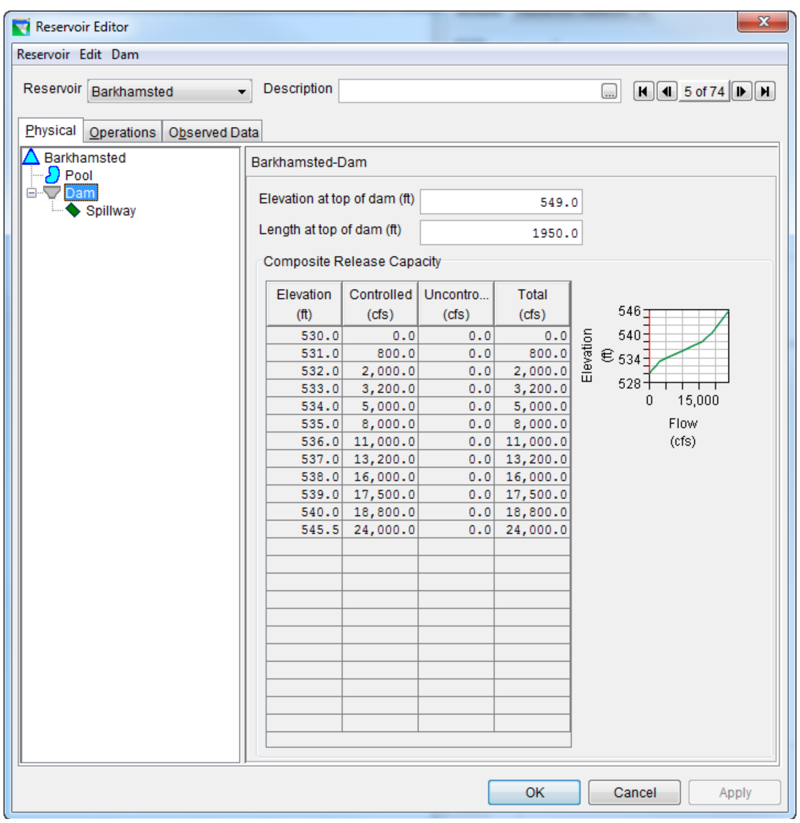


Figure 4: Reservoir Editor -- Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Barkhamsted's "Existing Ops" operational zones, which consist of the zones Top of Dam (549 ft), Conservation (530 ft), and Inactive (490 ft)[2].

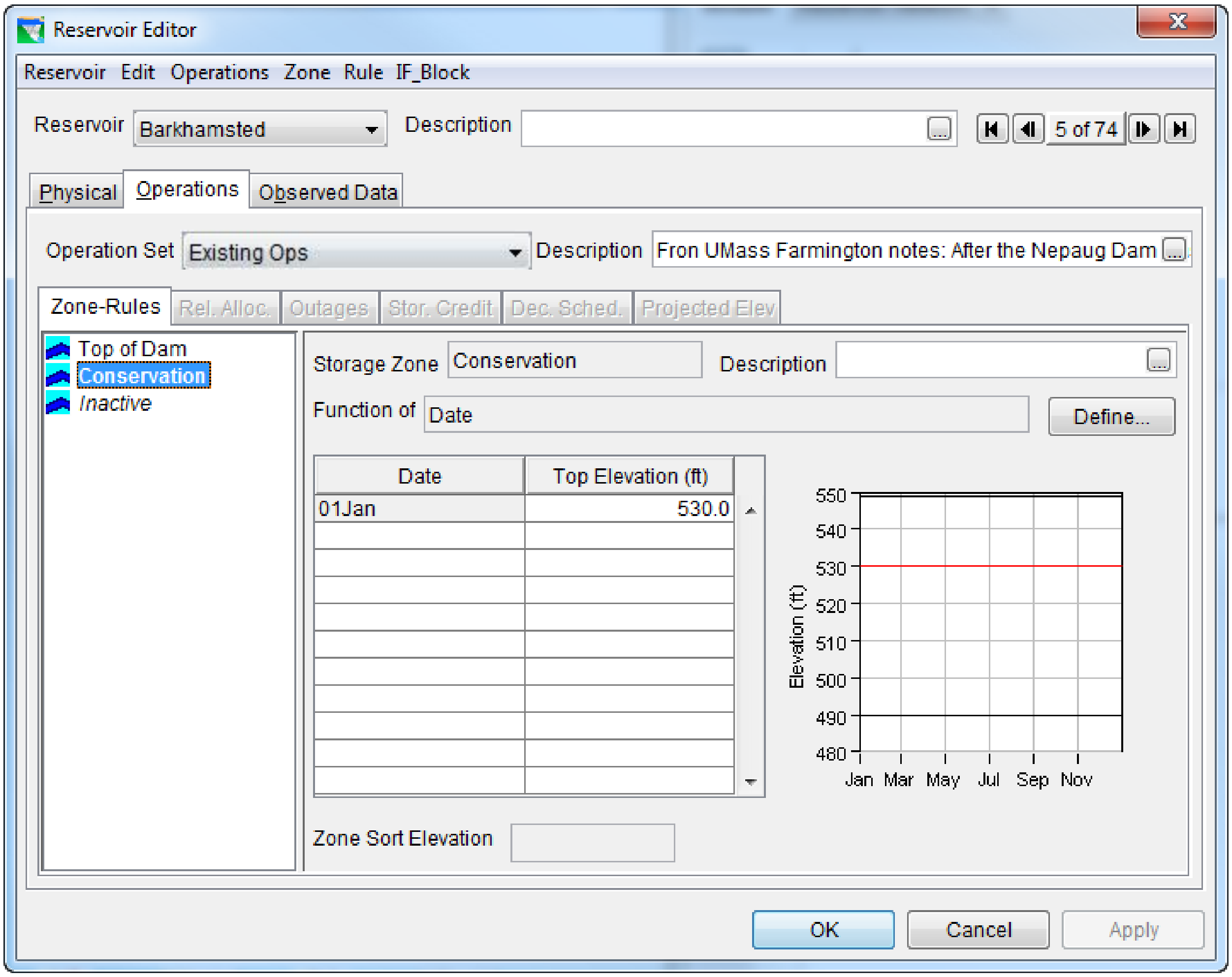


Figure 5: Reservoir Editor -- Operations Tab – Existing Ops OpSet

B. Rule Illustrations

The operation set for Barkhamsted has no operating rules, making it a through flow reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity. There is a water supply time series associated with Barkhamsted described in the Water Supply section of the report.

Barre Falls

I. Overview

The Barre Falls Dam is a dam in Barre, Massachusetts on the Ware River. It was constructed between 1956 and 1958 by the US Army Corps of Engineers and is still owned and operated by the Corps. It is primarily used for flood control but is also used for recreation.

Figure 1 shows the location of Barre Falls Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the dam.

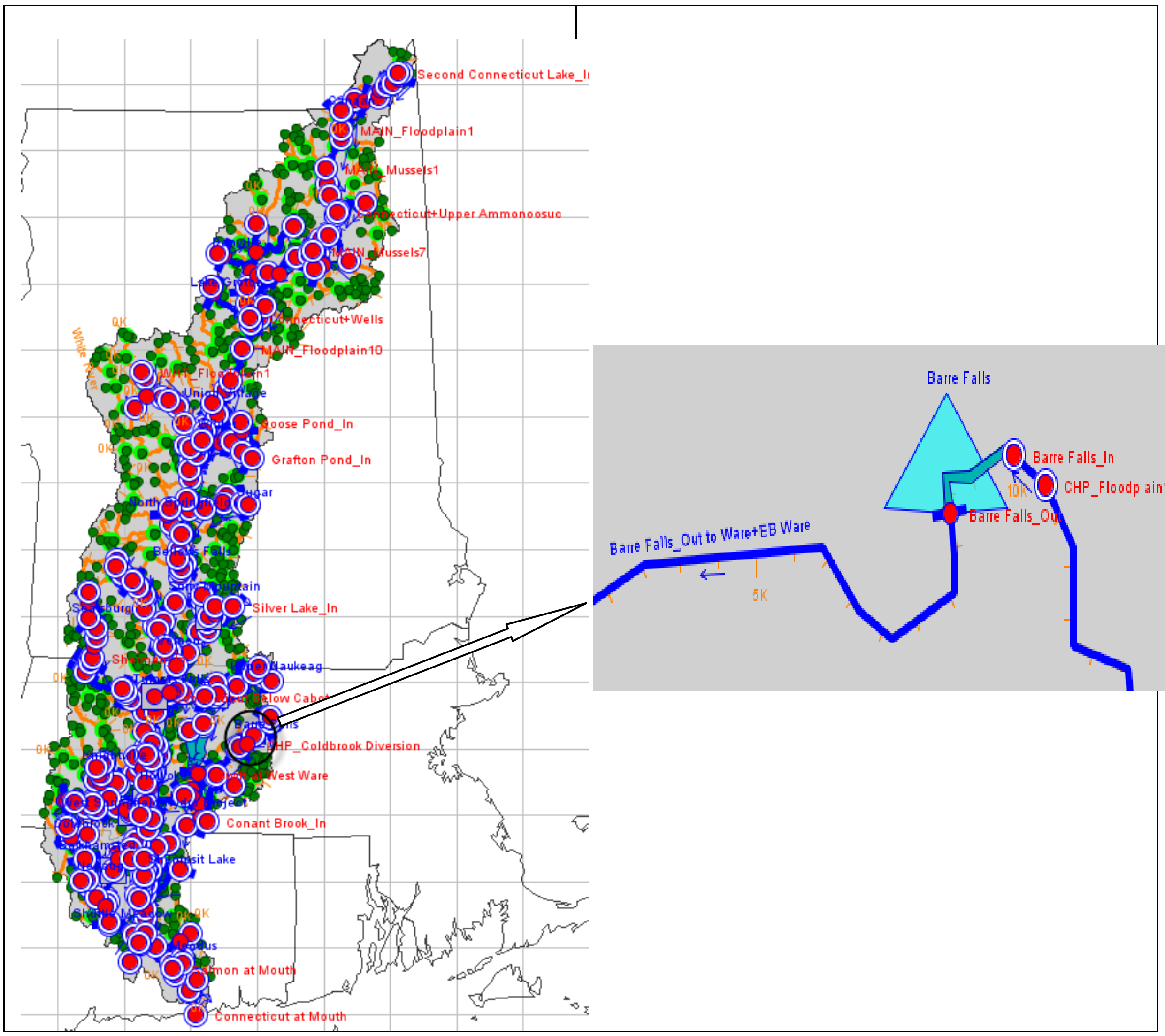


Figure 1: HEC-ResSim Map Display Showing Location of Barre Falls dam

Figure 2: Photo of Barre Falls Dam.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled Outlet, and (2) uncontrolled spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[4].

[4] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

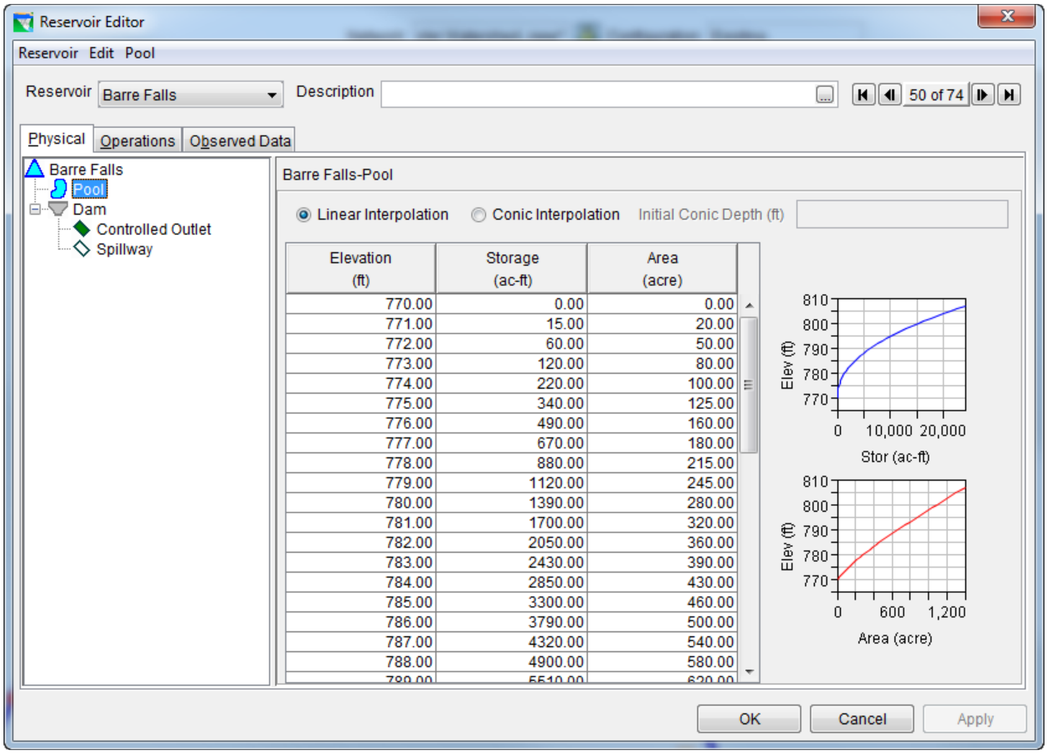


Figure 3: Reservoir Editor: Physical Tab -- Pool

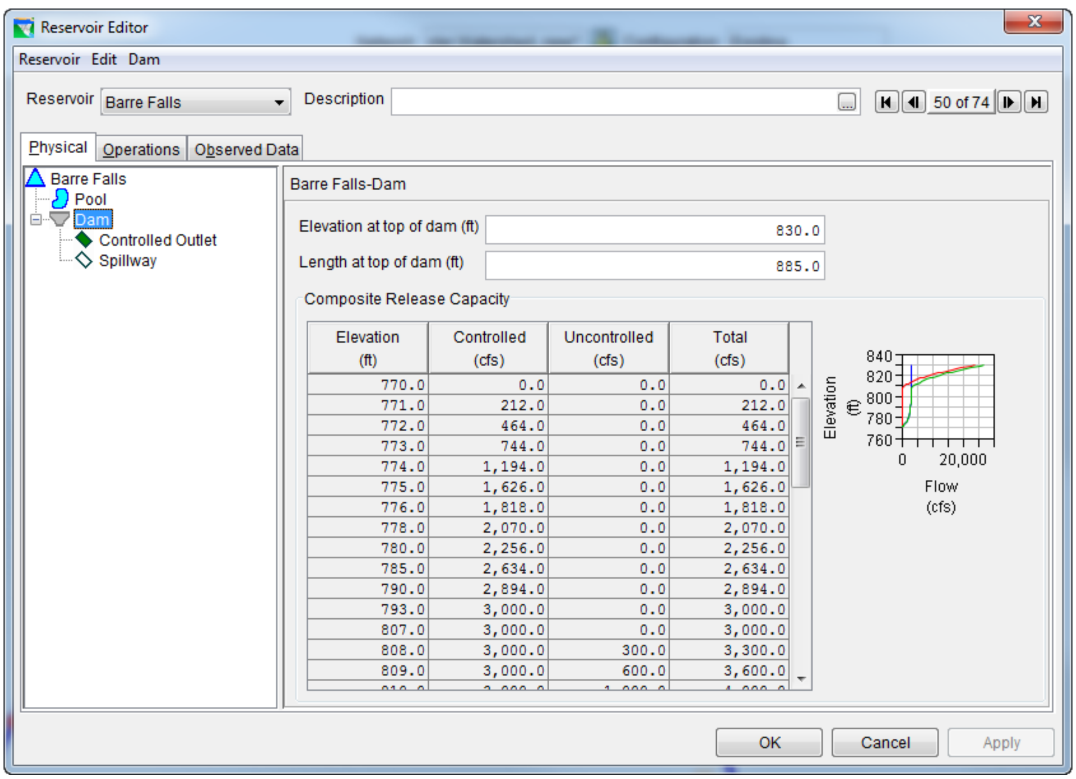


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Barre Falls's "Existing Ops" operational zones, which consist of zones of Surcharge (830 ft), Flood Control (807 ft), Conservation (772-776 ft), and Inactive zone (770 ft).

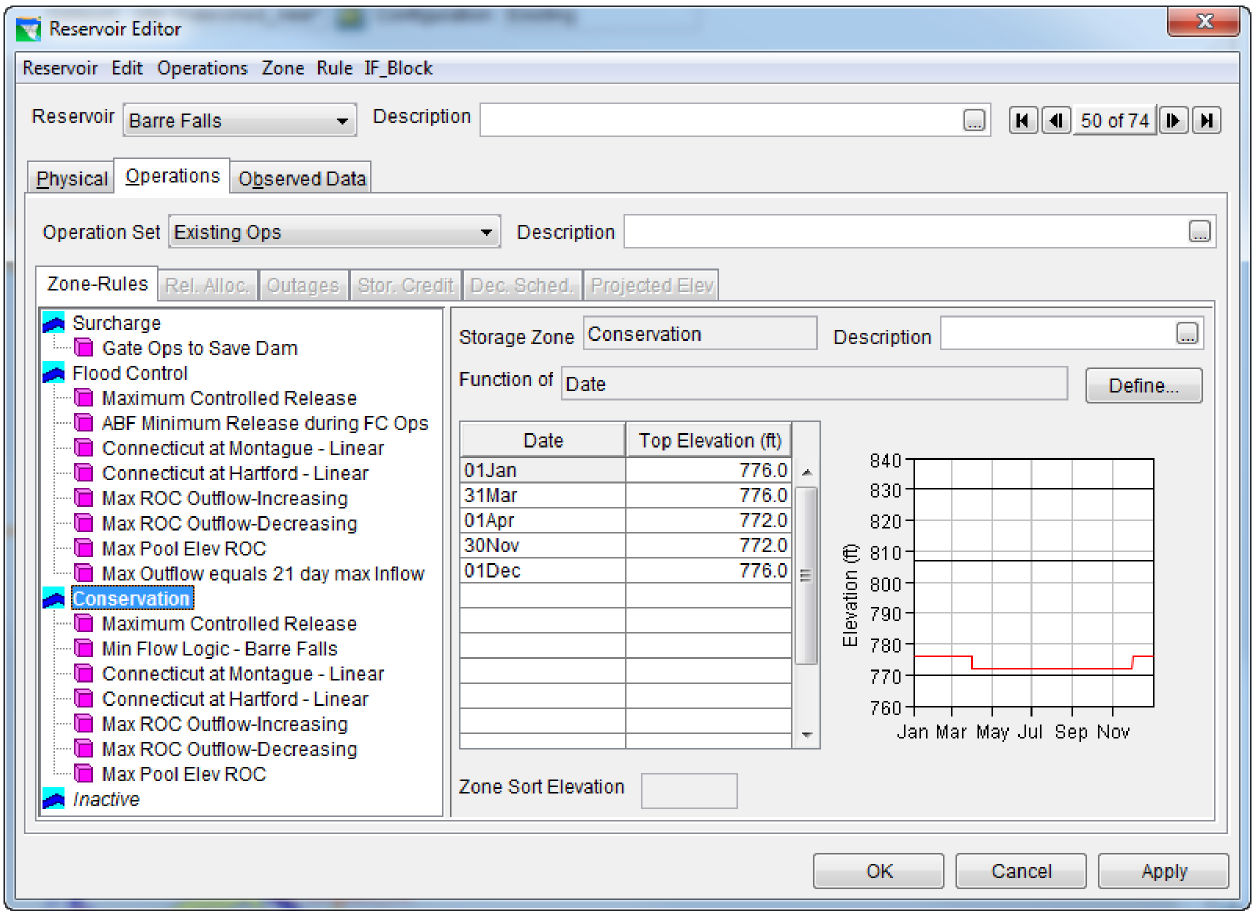


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

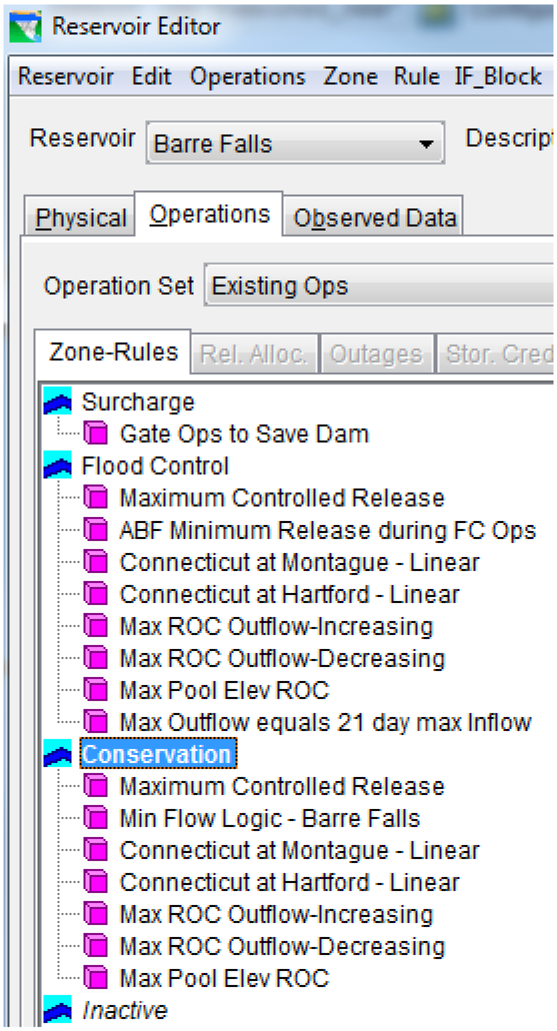


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Gate Ops to Save Dam

Figure 7 shows the content of “Gate Ops to Save Dam” rule. This rule represents the maximum allowable release from controlled outlet as a function of pool elevation when the pool is in surcharge zone.

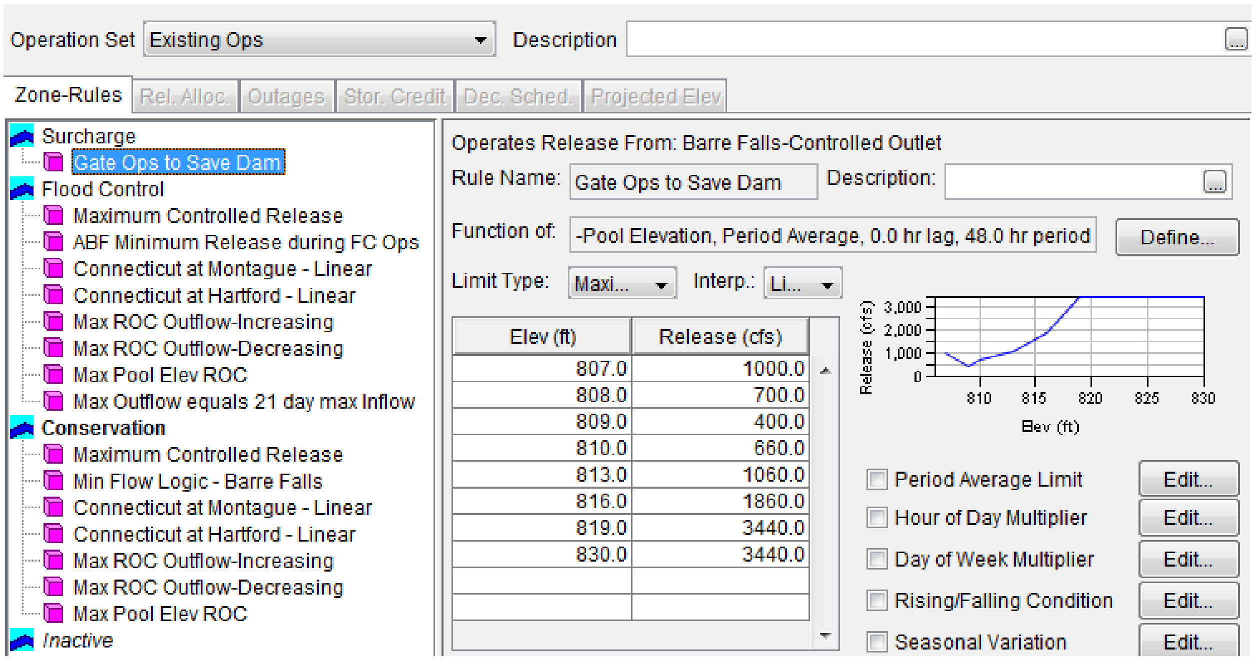


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet –Gate Ops to Save Dam

2. *Maximum Controlled Release*

Figure 8 shows the content of “Maximum Controlled Release” rule. This rule shows the maximum release from controlled outlet.

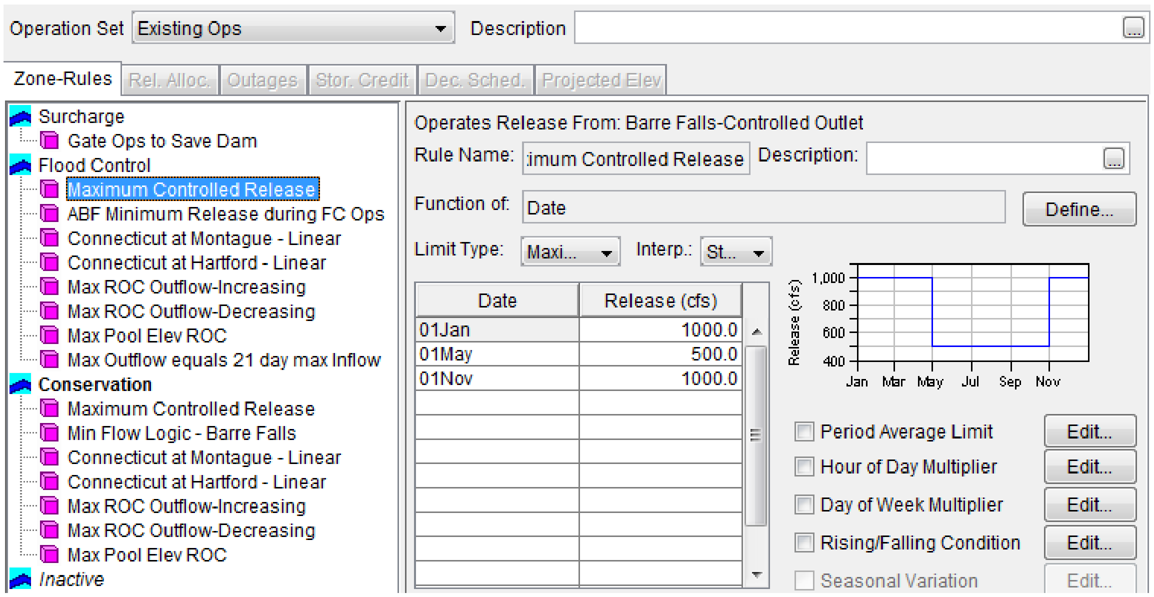


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maximum Controlled Release

3. *ABF Minimum Release during FC Ops*

Figure 9 shows the content of “ABF Minimum Release during FC Ops” rule. This rule assigns a 30 cfs release from the dam during flood control operations.

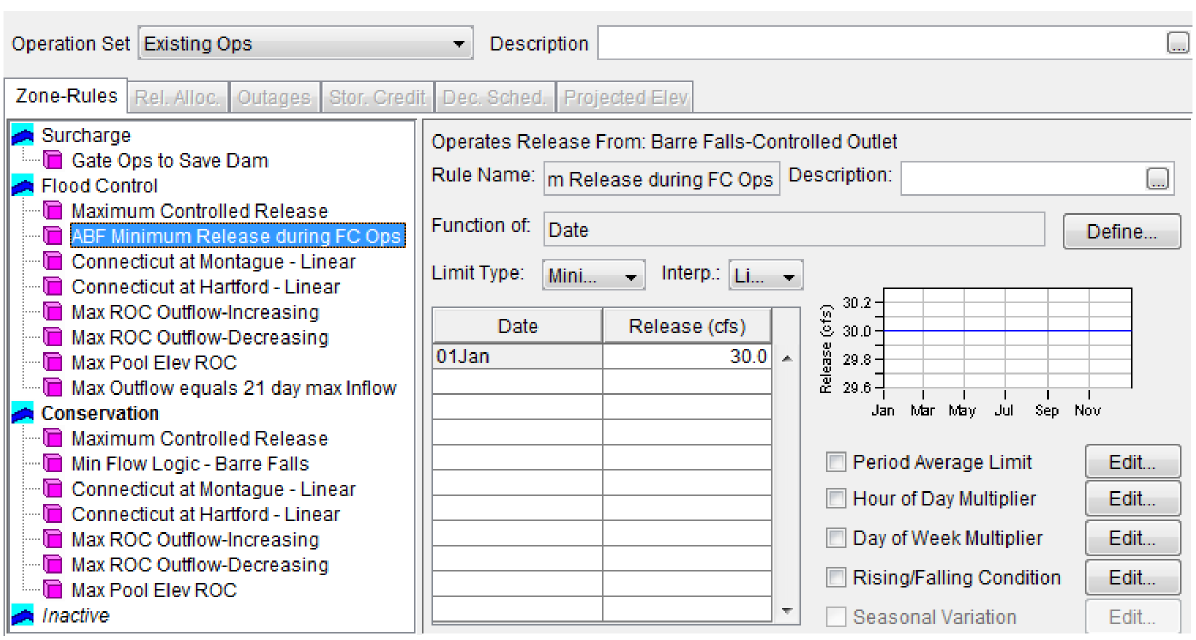


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – ABF Minimum Release during FC Ops

4. Connecticut at Montague-Linear

Figure 10 shows the content of "Connecticut at Montague-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montague. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

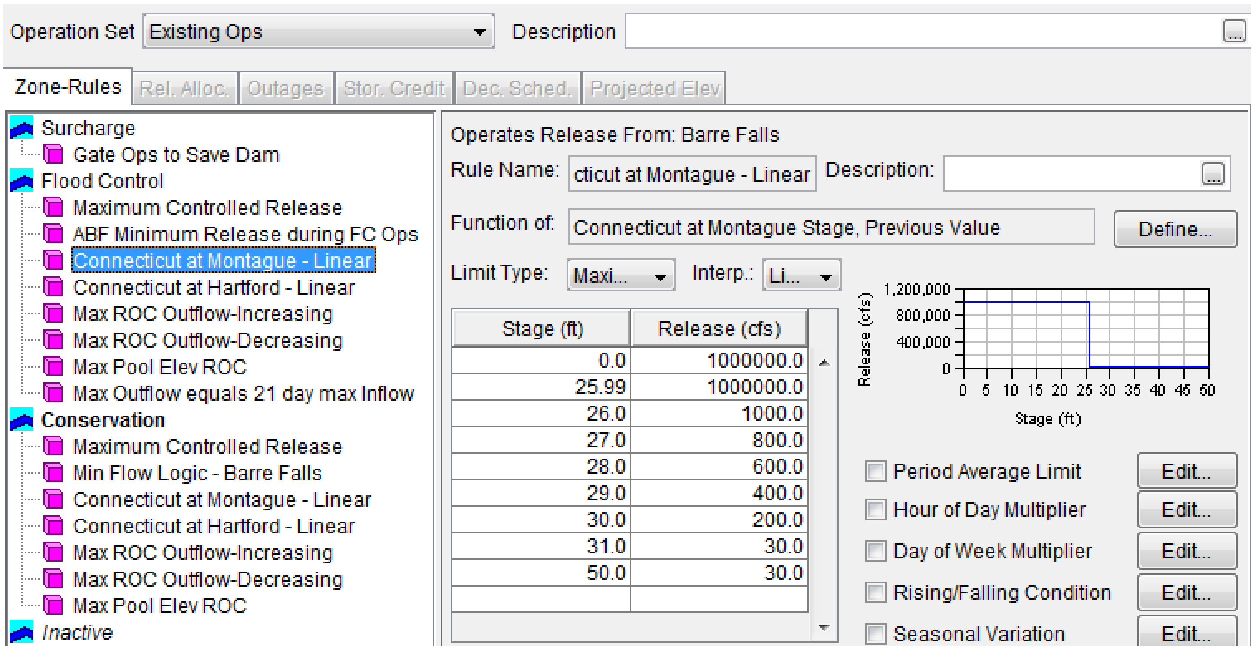
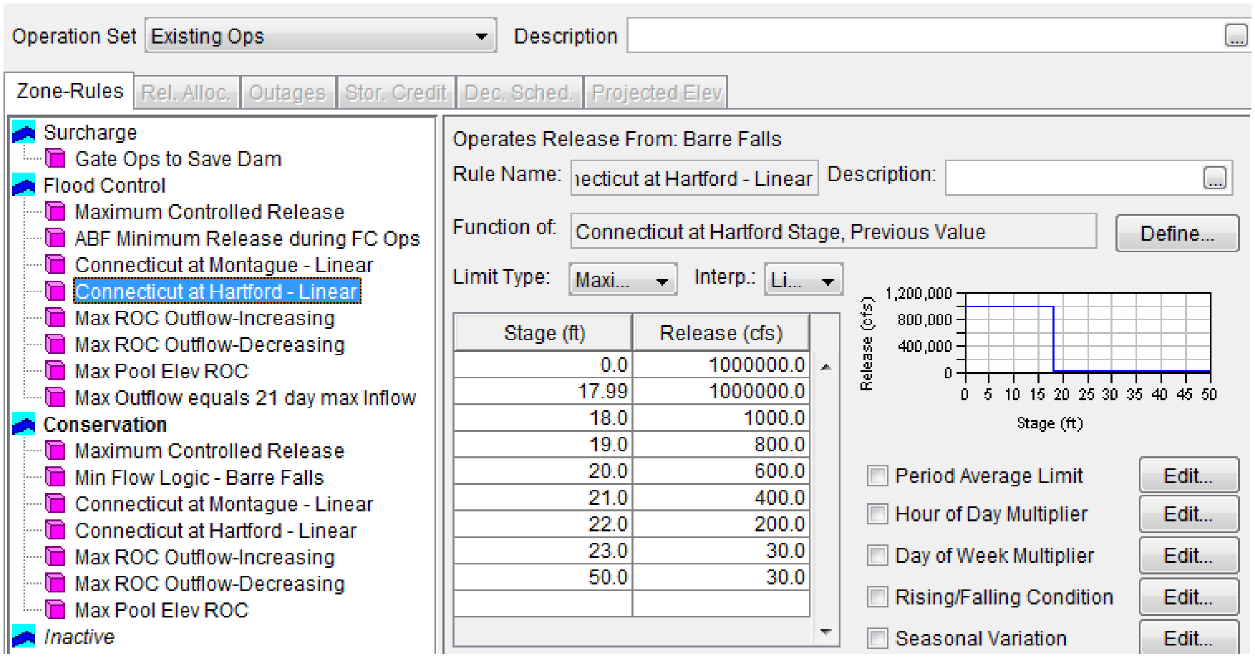


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague-Linear

5. *Connecticut at Hartford-Linear*

Figure 11 shows the content of "Connecticut at Hartford-Linear" rule. This rule represents the maximum allowable release from dam as a function of previous day stage at Hartford. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.



Stage (ft)	Release (cfs)
0.0	1000000.0
17.99	1000000.0
18.0	1000.0
19.0	800.0
20.0	600.0
21.0	400.0
22.0	200.0
23.0	30.0
50.0	30.0

Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Hartford-Linear

6. Max ROC Outflow-Increasing

Figure 12 shows the content of "MAX ROC Outflow-Increasing" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Barre falls dam.

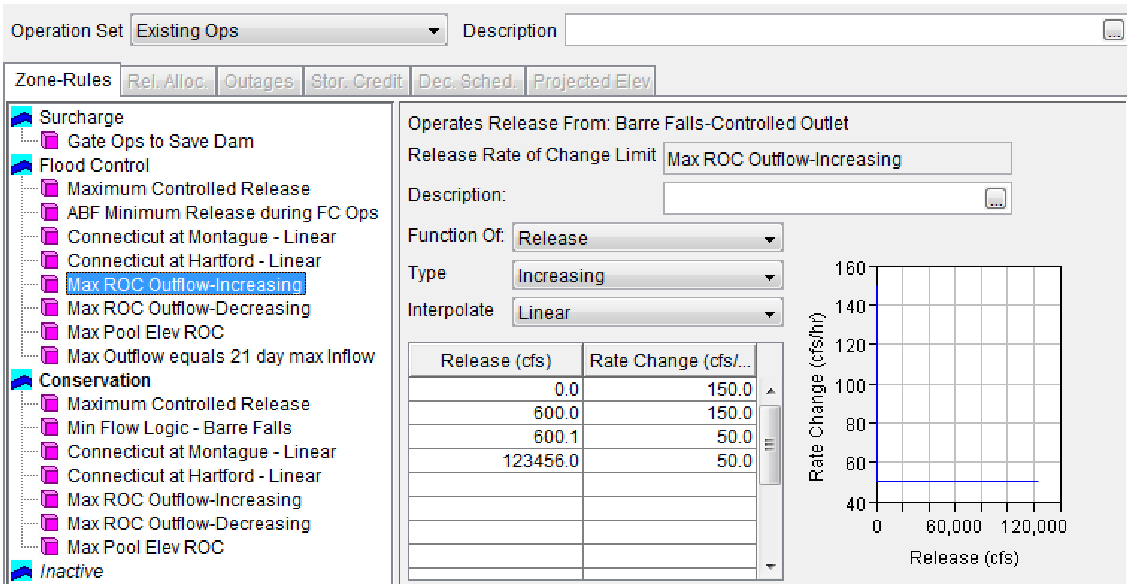


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet –MAX ROC Outflow-Increasing

7. Max ROC Outflow-Decreasing

Figure 13 shows the content of "MAX ROC Outflow-Decreasing" rule. This rule shows the maximum allowable decreasing release rate of change.

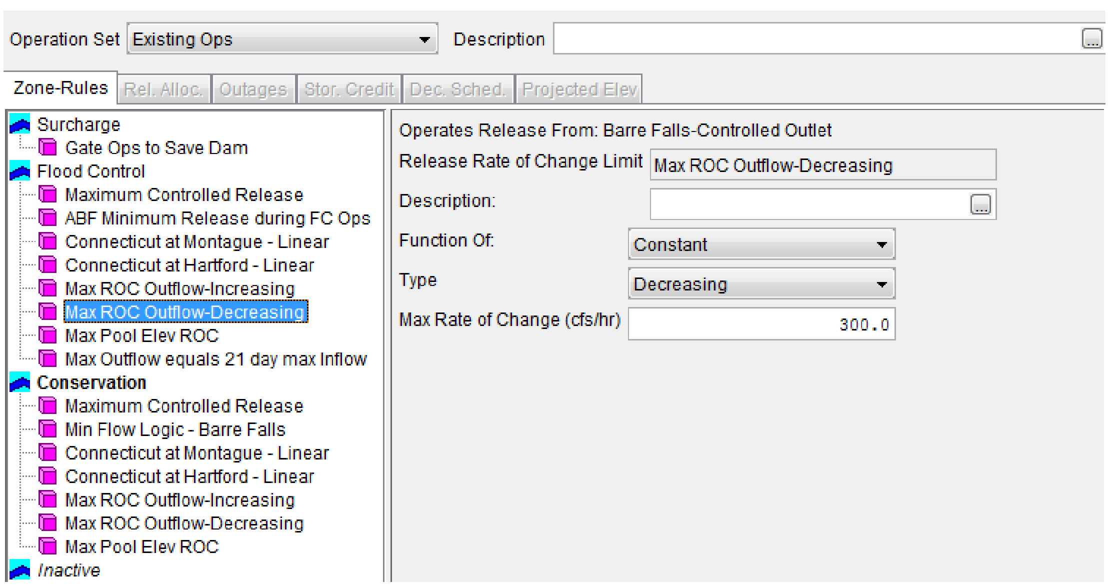


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – MAX ROC Outflow-Decreasing

8. Max Pool Elev ROC

Figure 14 shows the content of "Max Pool Elev ROC" rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

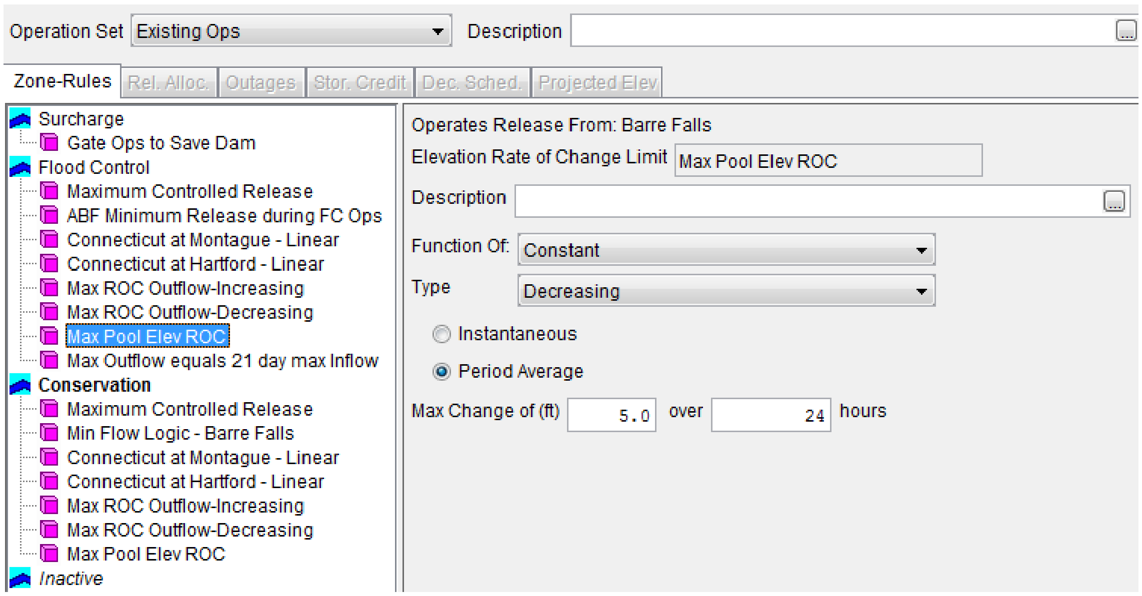


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max Pool Elev ROC

9. Max Outfow equals 21 day max inflow

Figure 15 shows the content of "Max Outflow equals 21 day max inflow" rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

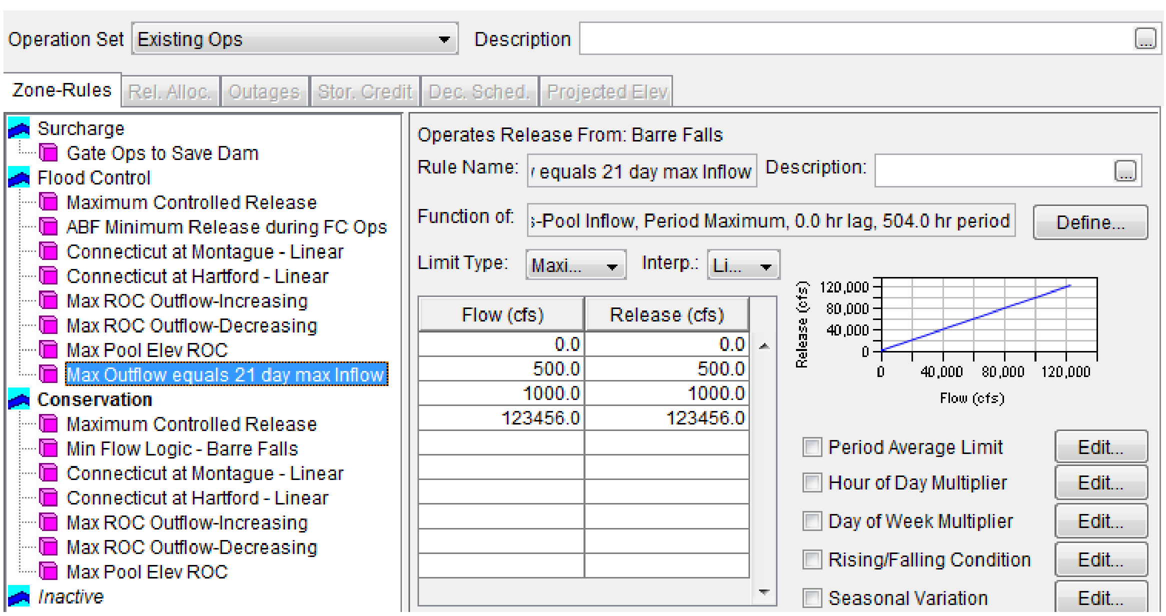


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals 21 day max inflow

10. Min Flow Logic-Barre Falls

Figure 16 shows the content of “Min Flow Logic-Barre Falls” rule. This rule describes a seasonal minimum flow rule from controlled outlets as a function of inflow at Barre falls.

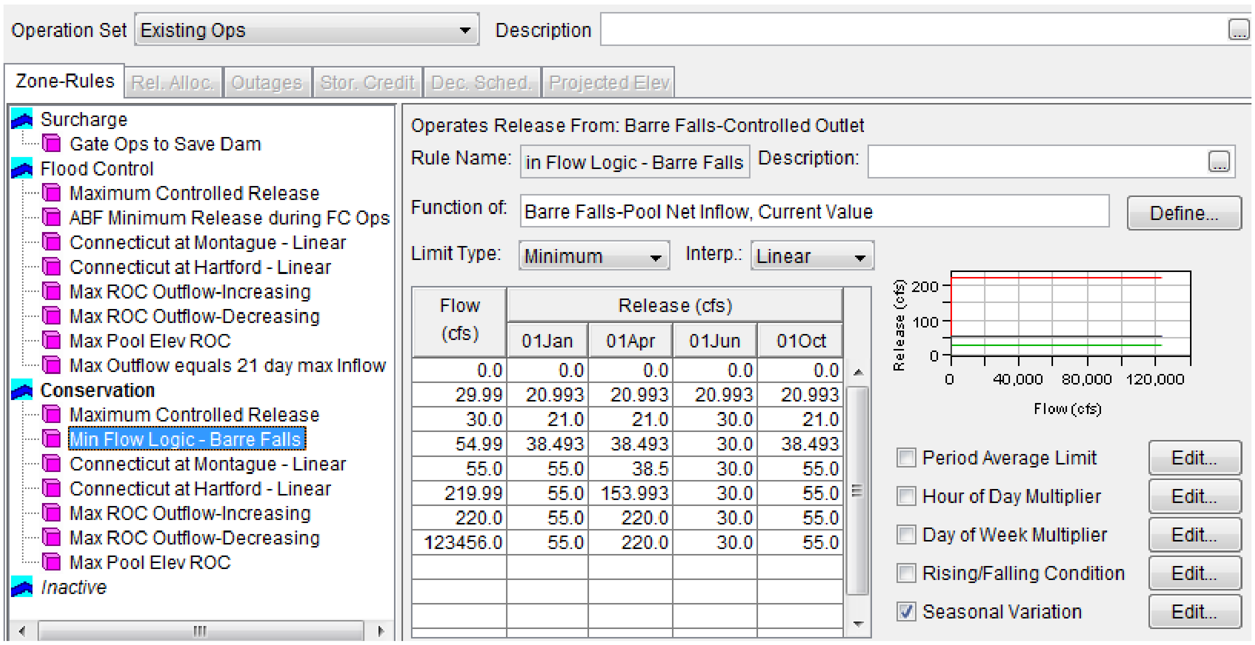


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic-Barre Falls

Bashan

I. Overview

The dam was constructed in 1939 and is used for recreation. It is owned by the state of Connecticut and is under the control of the Department of Environmental Protection. The lake area is 276 acres, about 21% of the its total drainage area. In 2011, funds were allocated to repair the dam and to decrease the risk of the dam overtopping during a flood event.

Figure 1 shows the location of Bashan reservoir as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Bashan Dam.

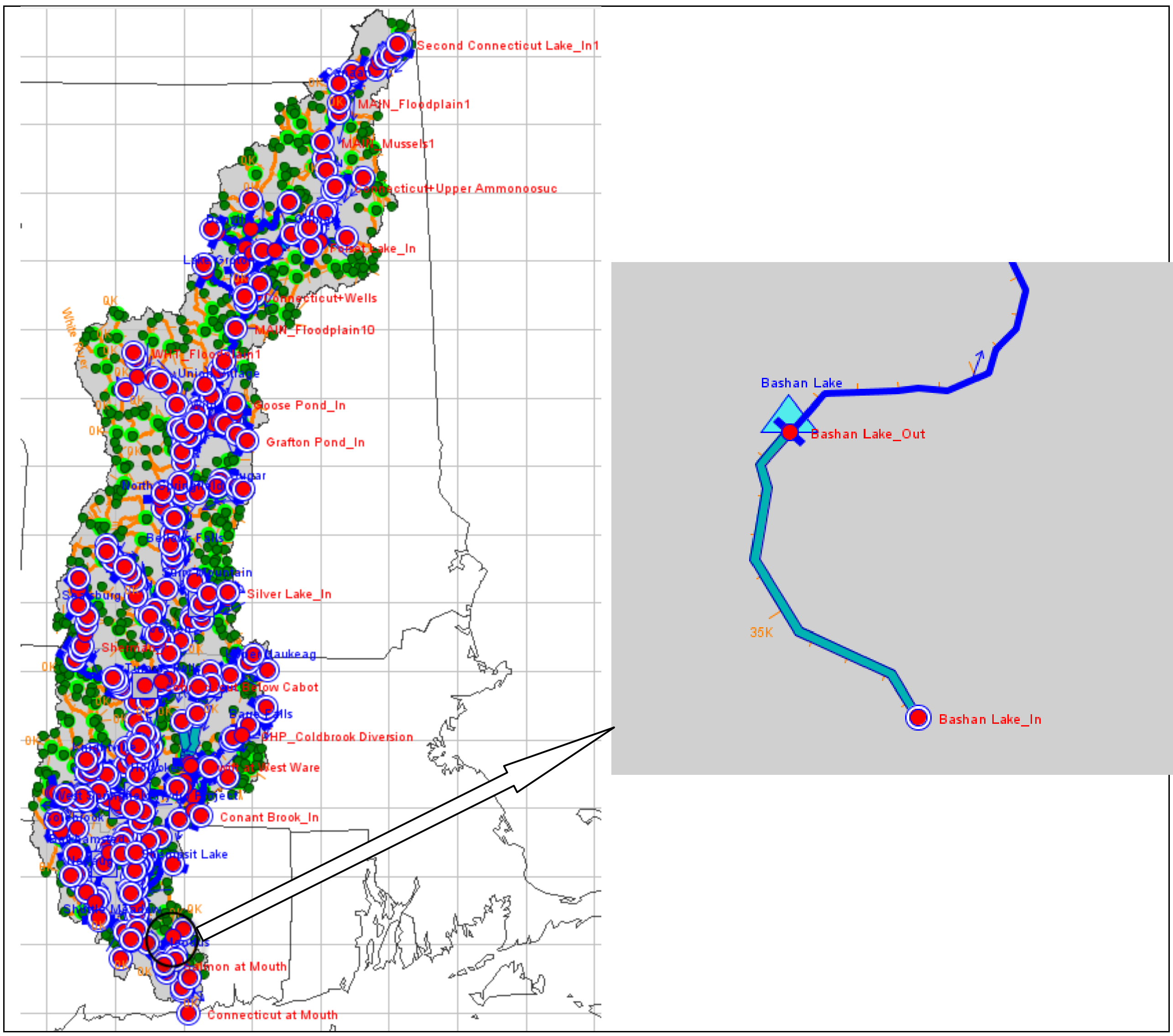


Figure 1: HEC-ResSim Map Display Showing Location of Bashan Dam

Figure 2: Aerial photo of Bashan Lake Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[5]. The dam consists of three different outlets: (1) an uncontrolled spillway, (2) an uncontrolled right embankment, and (3) an uncontrolled left embankment as shown in Figure 4. These three uncontrolled were modeled as weirs, with data shown in Table 1[6].

[5] Provided by the operators of Bashan

[6] WMC Consulting Engineers. Preliminary Design Report. Newington, CT 2012.

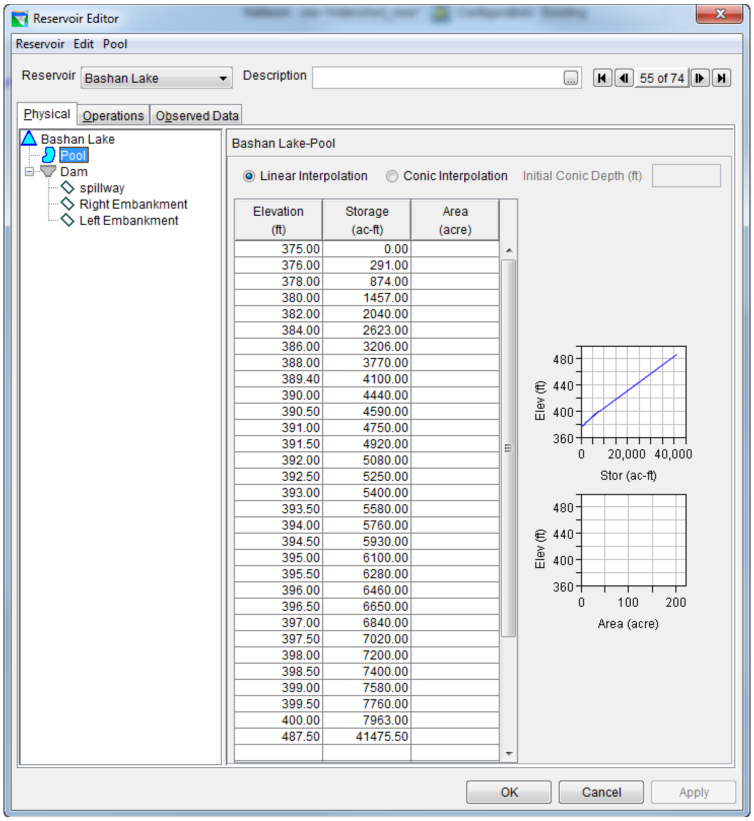


Figure 3: Reservoir Editor -- Physical Tab -- Pool

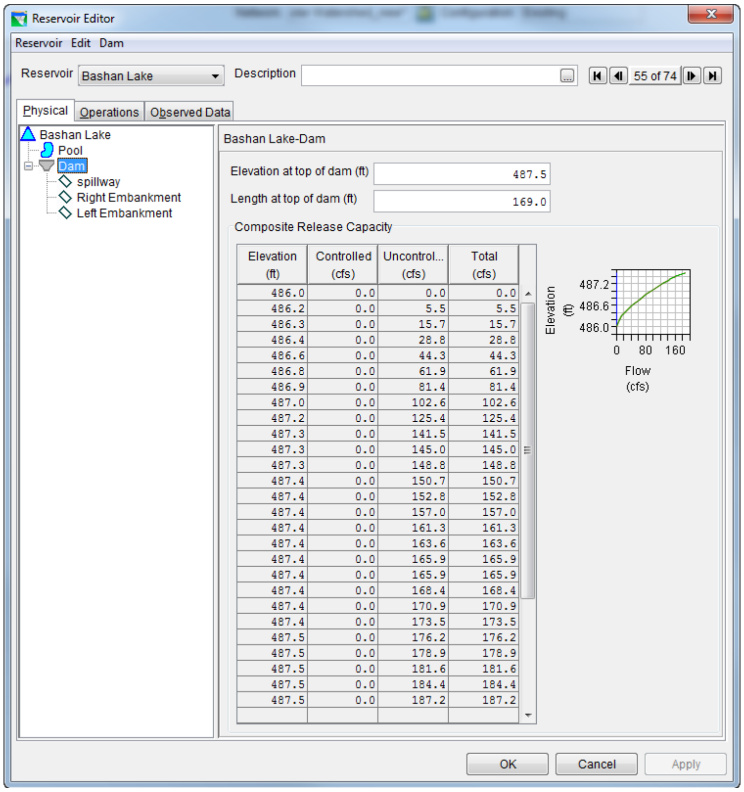


Figure 4: Reservoir Editor -- Physical Tab -- Dam

Table 1: Weir Data

	Outlet Elevation (ft)	Weir Coef.	Length (ft)
Spillway	486	3.3	28.9
Right Embankment	487.4	3.3	30.0
Left Embankment	487.3	3.3	30.0

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 4 shows the definition of Bashan's "Guide Curve" operational zones, which consist of the zones Flood Control (487.5 ft), Conservation (486 ft), and Inactive (400 ft). The zone elevations were based off the top of the elevation-storage curve and the spillway outlet elevation.

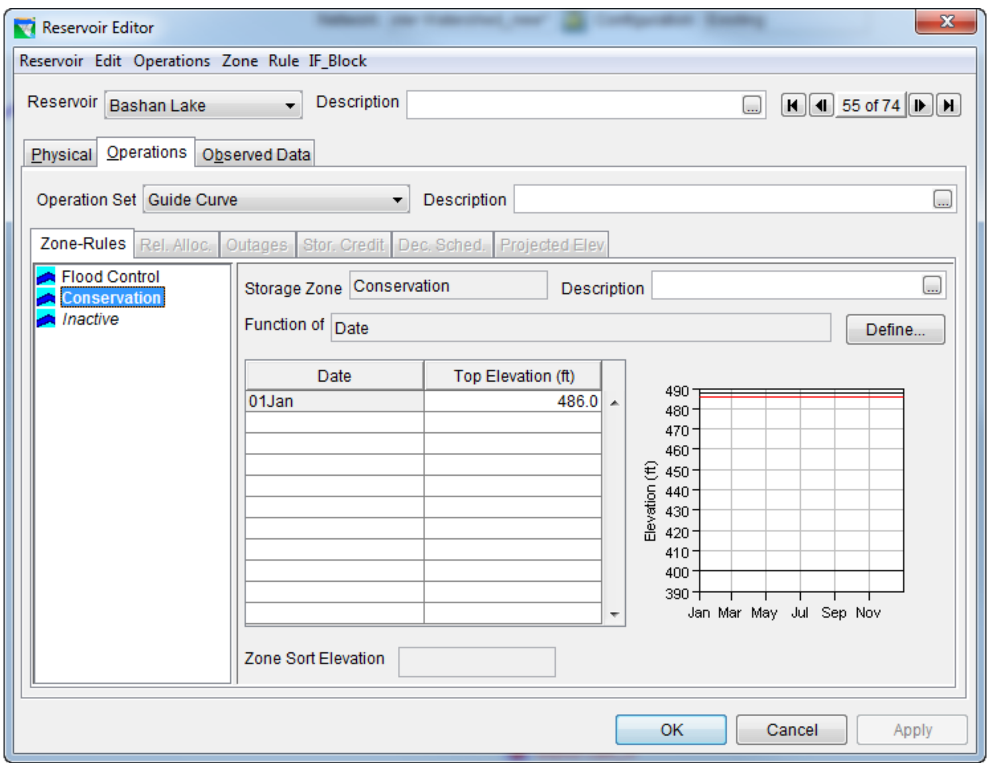


Figure 5: Reservoir Editor -- Operations Tab – Guide Curve OpSet

B. Rule Illustrations

The operation set for Bashan has no operating rules, making it a through flow reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Bear Swamp

I. Overview

Bear Swamp is pump-storage and run-of-river hydropower generating facility (the run-of-river facility is called Fife Brook) on the Deerfield River in Rowe, MA. It is currently owned and operated by Brookfield Renewable Power Inc. and is primarily used for hydropower generation. It is also used to make whitewater releases for whitewater rafting.

Figure 1 shows the location of Bear Swamp Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Bear Swamp dam.

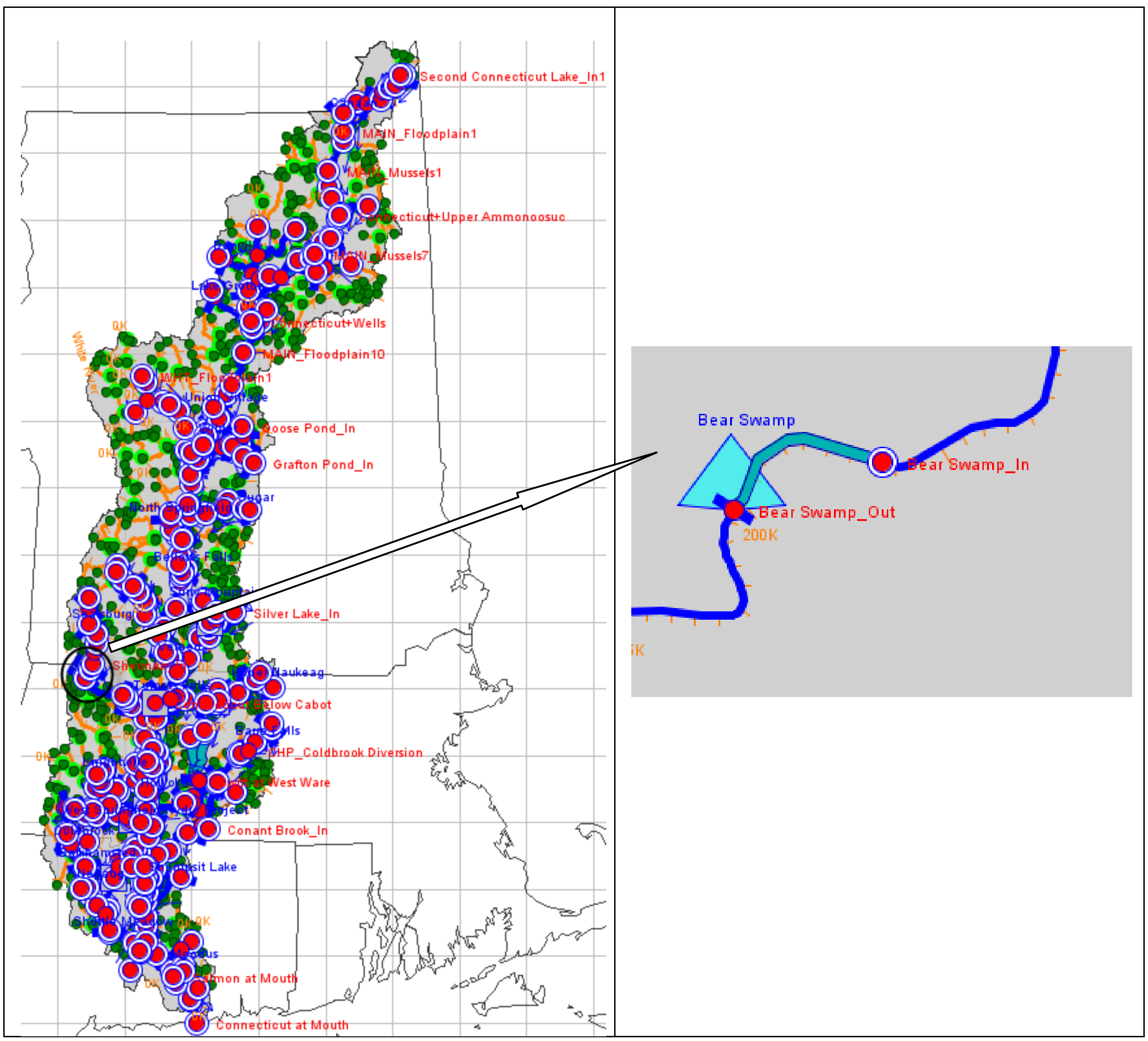


Figure 1: HEC-ResSim Map Display Showing Location of Bear Swamp dam

Figure 2: Photo of Bear Swamp Dam

II. Physical Characteristics

Only the physical and operational characteristics of the river portion of the project are modeled. The pump-storage part of the project was not modeled because it was deemed unnecessary. The pump-storage is operates on the same volume of water, all flow from upstream is passed through the river portion of the project

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[7]. The dam consists of three types of outlets: (1) controlled tainter gate, (2) controlled 30 inch pipe, and (3) power plant as shown in Figure 4.

[7] Brookfield Renewable Power Inc. Brookfield – Bear Swamp Pump Storage Project. 2012

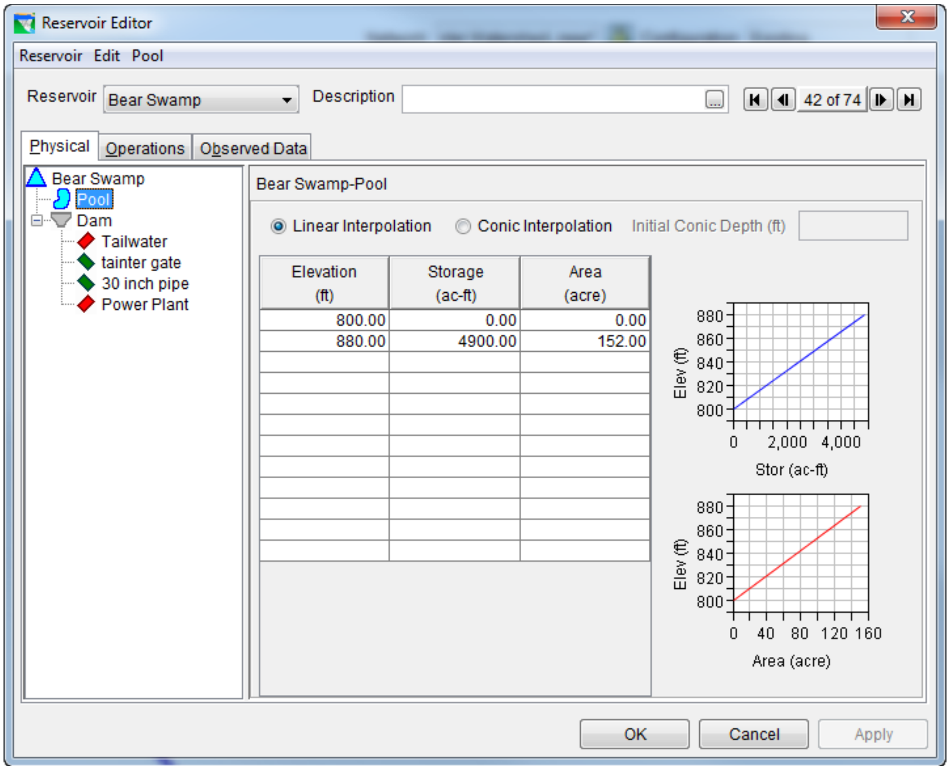


Figure 3: Reservoir Editor: Physical Tab -- Pool

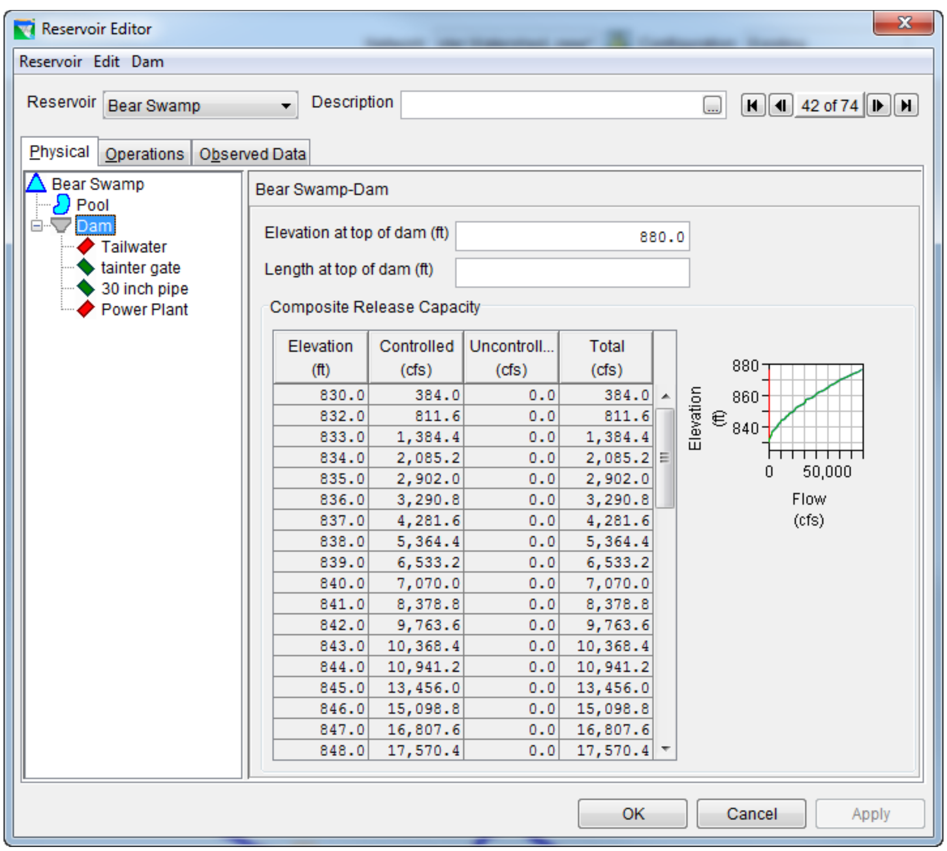


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 4 shows the definition of Bear Swamp's "Guide Curve" operational zones, which consist of zones of Top of dam (880 ft), Flood Control (870 ft), Conservation (850 ft), and Inactive zone (800 ft)[1].

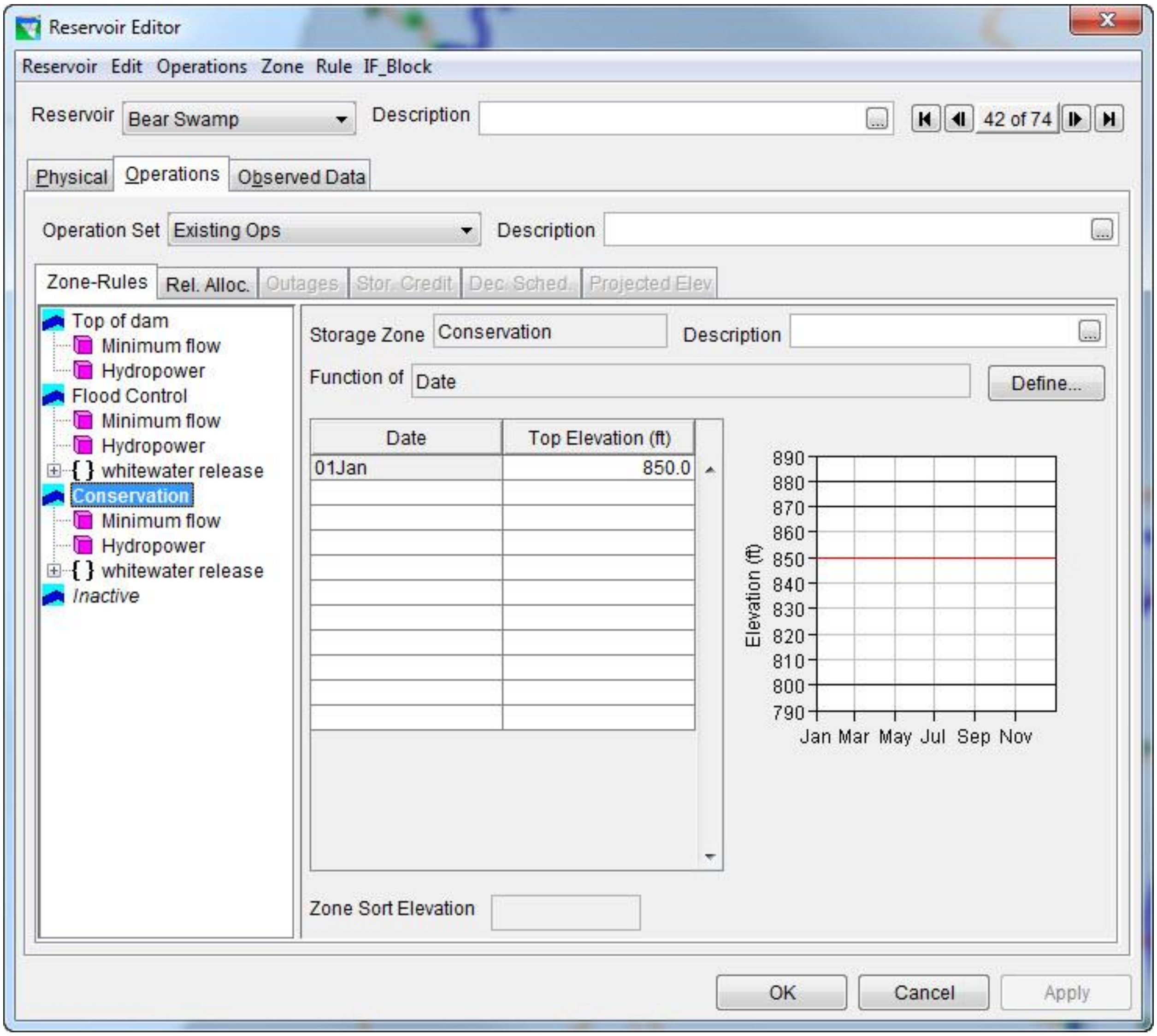


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Guide Curve.

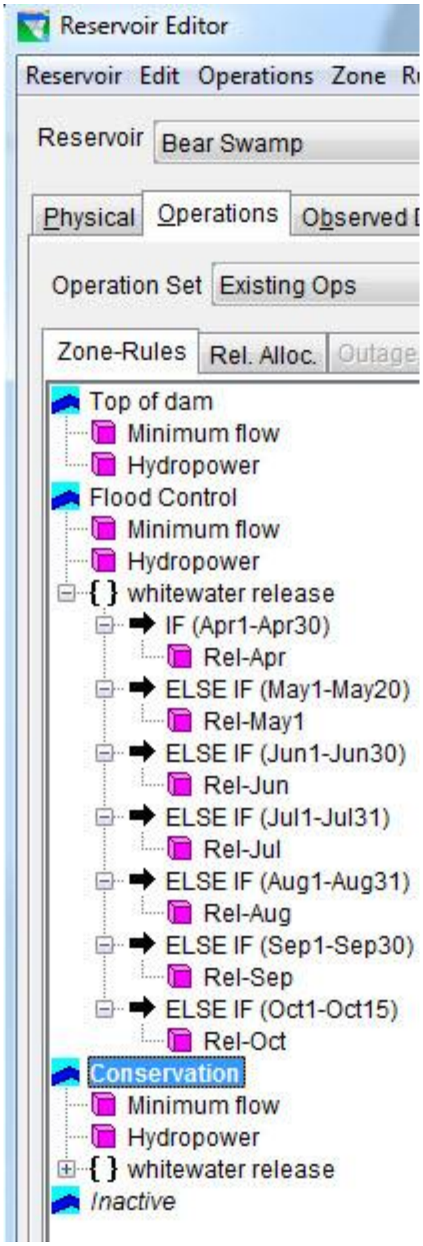


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. *Minimum flow*

Figure 7 shows the content of "Minimum flow" rule. This rule assigns 125 cfs as a minimum release from 30 inch pipe controlled outlet.

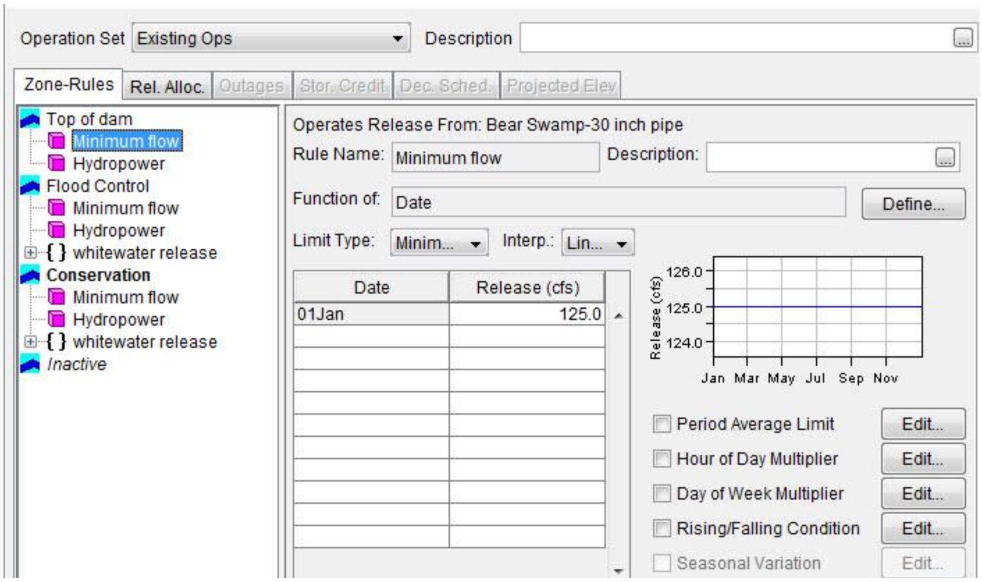


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Minimum flow

2. *Hydropower*

Figure 8 shows the content of "Hydropower" rule. This rule releases 95% of inflow through power plant as per the run-of-river hydropower strategy.

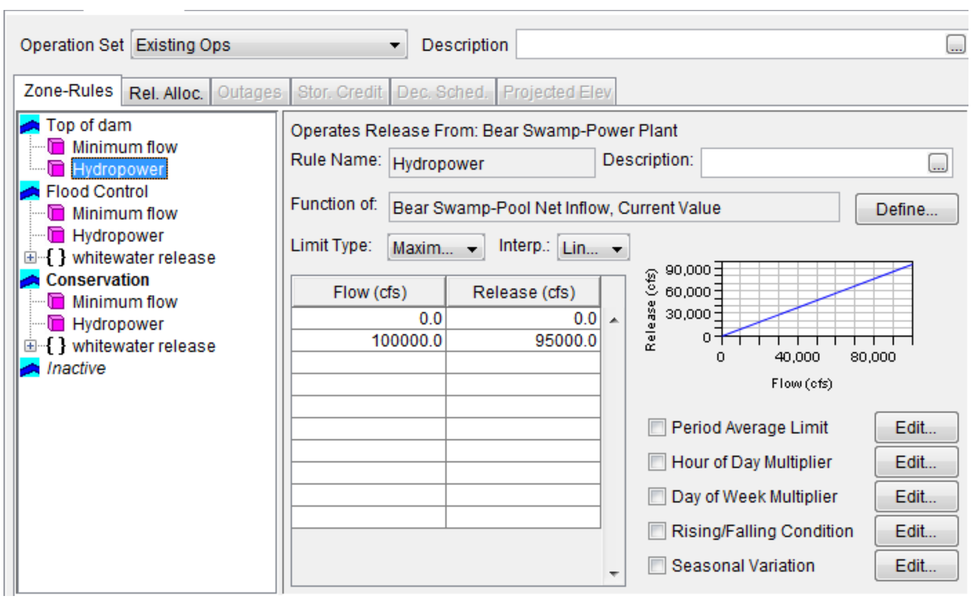
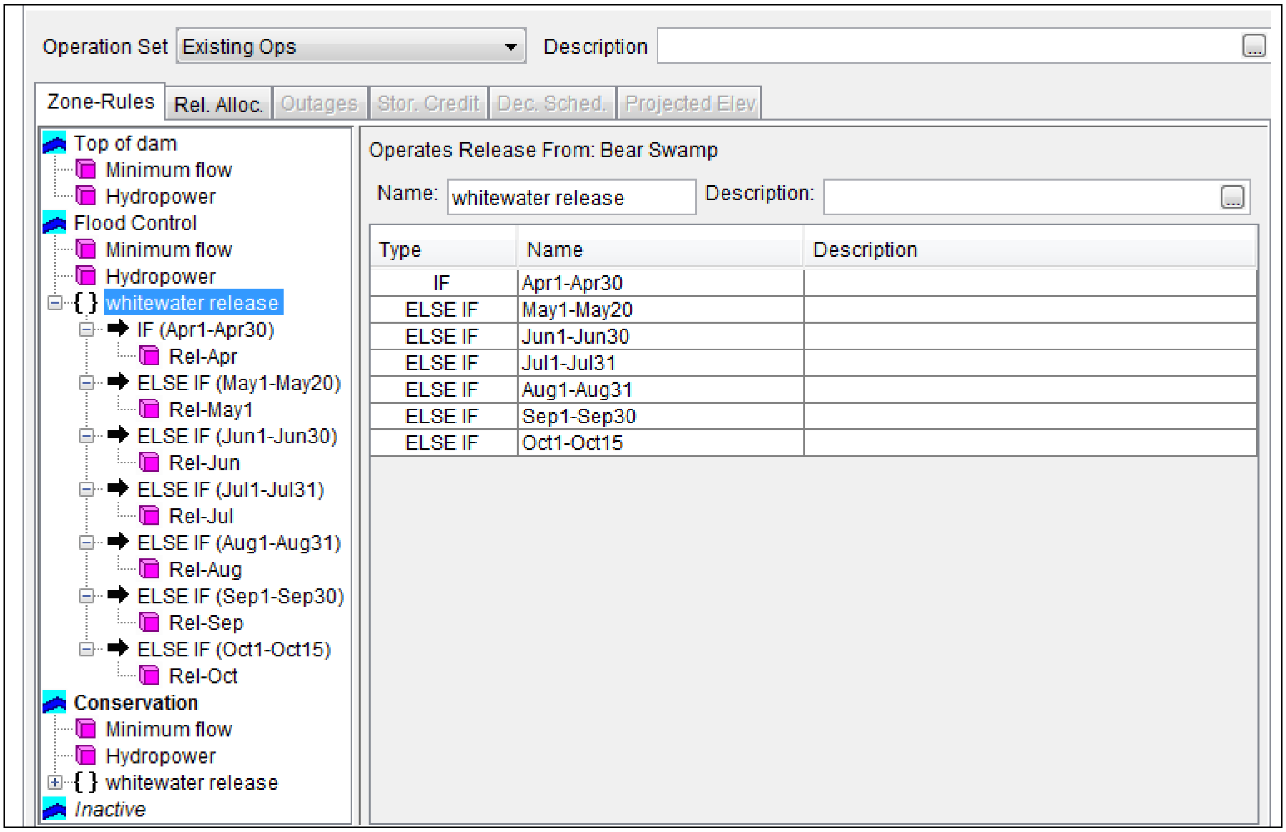


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet –Hydropower

3. *Whitewater release*

Figure 9 shows the content of "Whitewater release" rule. This rule releases 700 cfs through power plant with different schedules during different months of the year.



- Top of dam
  - Minimum flow
  - Hydropower
- Flood Control
  - Minimum flow
  - Hydropower
  - { } whitewater release
    - IF (Apr1-Apr30)
      - Rel-Apr
    - ELSE IF (May1-May20)
      - Rel-May1
    - ELSE IF (Jun1-Jun30)
      - Rel-Jun
    - ELSE IF (Jul1-Jul31)
      - Rel-Jul
    - ELSE IF (Aug1-Aug31)
      - Rel-Aug
    - ELSE IF (Sep1-Sep30)
      - Rel-Sep
    - ELSE IF (Oct1-Oct15)
      - Rel-Oct

Operates Release From: Bear Swamp
Rule Name: Rel-Apr
Function of: Date
Limit Type: Mi... Interp.: ...

Date	Release (cfs)
01Jan	700.0

Time of Day	Multiplier
0000-0100	0.0
0100-0200	0.0
0200-0300	0.0
0300-0400	0.0
0400-0500	0.0
0500-0600	0.0
0600-0700	0.0
0700-0800	0.0
0800-0900	0.0
0900-1000	1.0
1000-1100	1.0
1100-1200	1.0
1200-1300	0.0
1300-1400	0.0
1400-1500	0.0
1500-1600	0.0
1600-1700	0.0
1700-1800	0.0
1800-1900	0.0
1900-2000	0.0
2000-2100	0.0
2100-2200	0.0
2200-2300	0.0
2300-2400	0.0

Day	Multiplier
Sun	1.00
Mon	0.00
Tues	0.00
Wed	1.00
Thurs	1.00
Fri	1.00
Sat	1.00

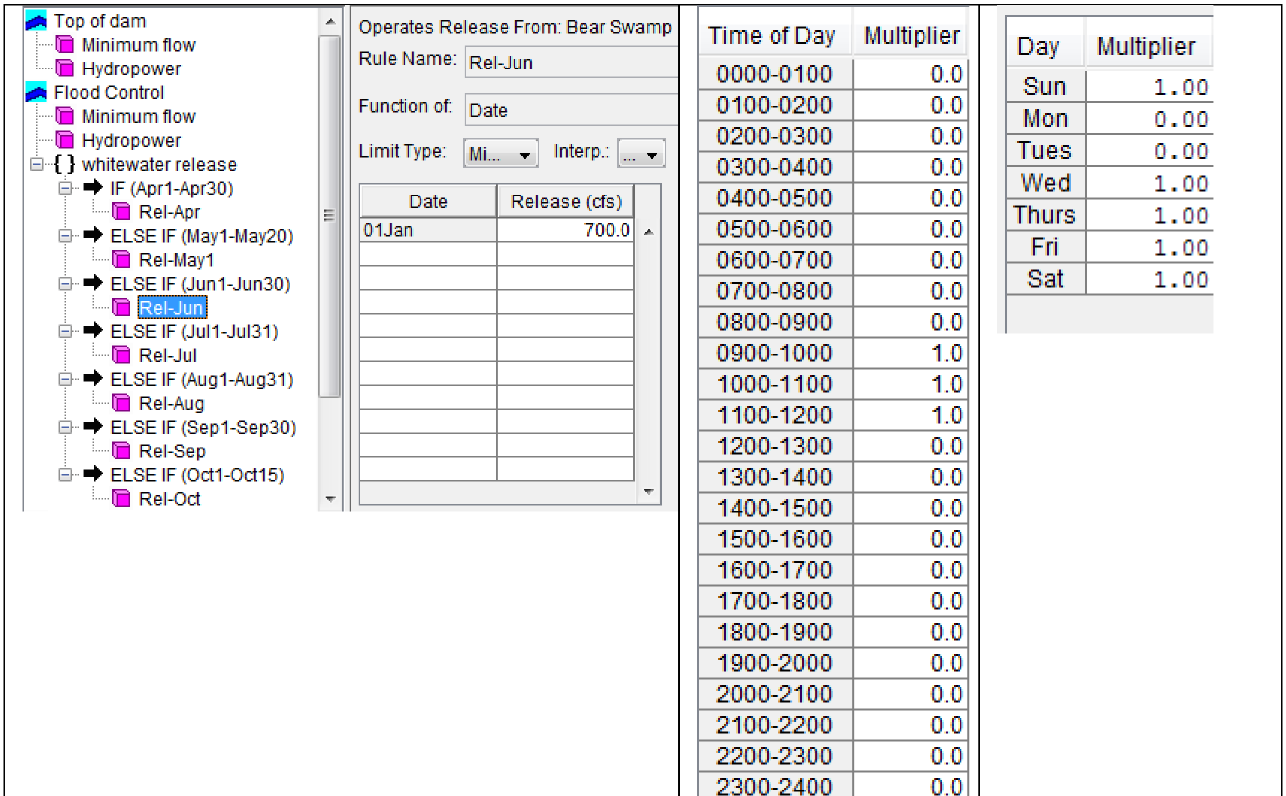
- Top of dam
  - Minimum flow
  - Hydropower
- Flood Control
  - Minimum flow
  - Hydropower
  - { } whitewater release
    - IF (Apr1-Apr30)
      - Rel-Apr
    - ELSE IF (May1-May20)
      - Rel-May1
    - ELSE IF (Jun1-Jun30)
      - Rel-Jun
    - ELSE IF (Jul1-Jul31)
      - Rel-Jul
    - ELSE IF (Aug1-Aug31)
      - Rel-Aug
    - ELSE IF (Sep1-Sep30)
      - Rel-Sep
    - ELSE IF (Oct1-Oct15)
      - Rel-Oct

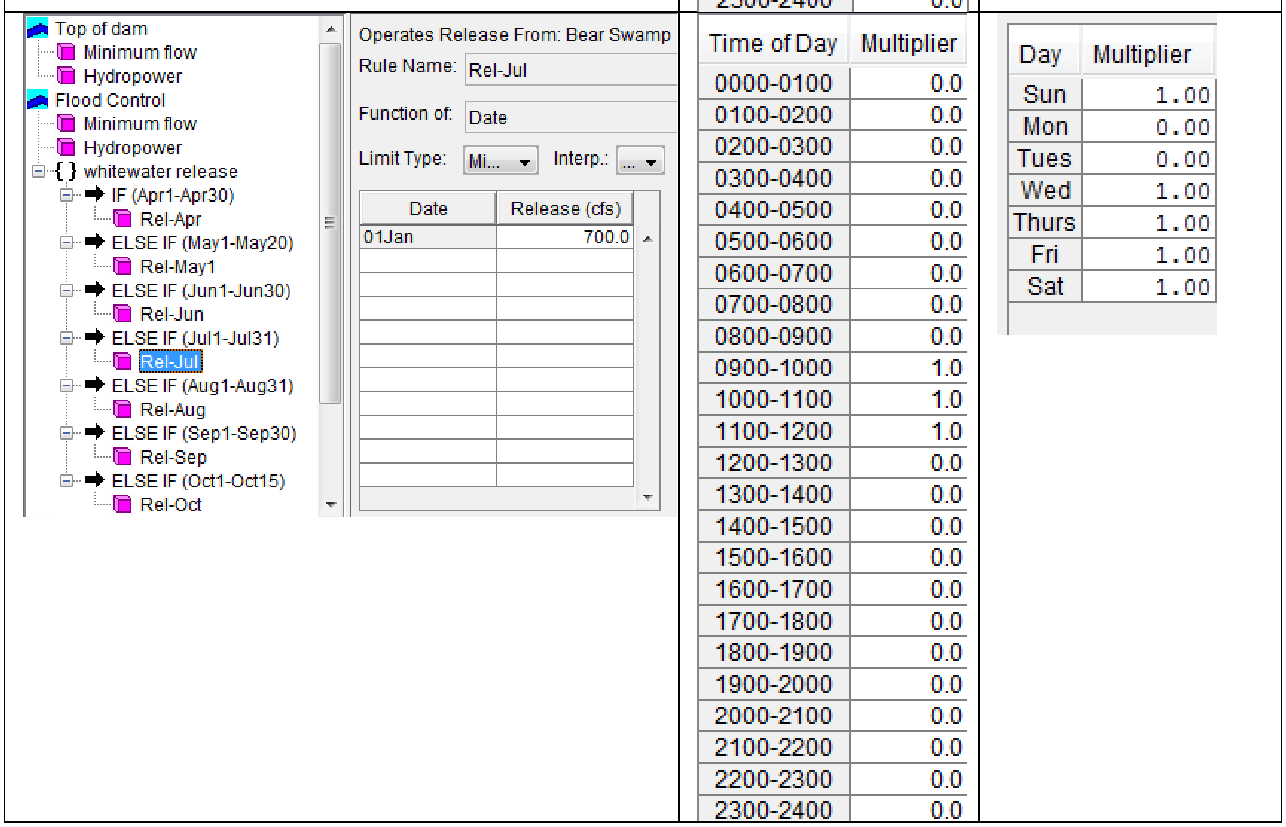
Operates Release From: Bear Swamp
Rule Name: Rel-May1
Function of: Date
Limit Type: Mi... Interp.: ...

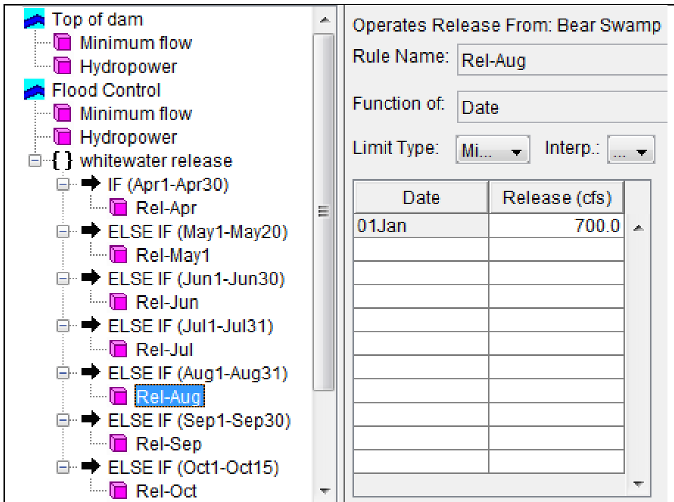
Date	Release (cfs)
01Jan	700.0

Time of Day	Multiplier
0000-0100	0.0
0100-0200	0.0
0200-0300	0.0
0300-0400	0.0
0400-0500	0.0
0500-0600	0.0
0600-0700	0.0
0700-0800	0.0
0800-0900	0.0
0900-1000	1.0
1000-1100	1.0
1100-1200	1.0
1200-1300	0.0
1300-1400	0.0
1400-1500	0.0
1500-1600	0.0
1600-1700	0.0
1700-1800	0.0
1800-1900	0.0
1900-2000	0.0
2000-2100	0.0
2100-2200	0.0
2200-2300	0.0
2300-2400	0.0

Day	Multiplier
Sun	1.00
Mon	0.00
Tues	0.00
Wed	0.00
Thurs	0.00
Fri	0.00
Sat	1.00

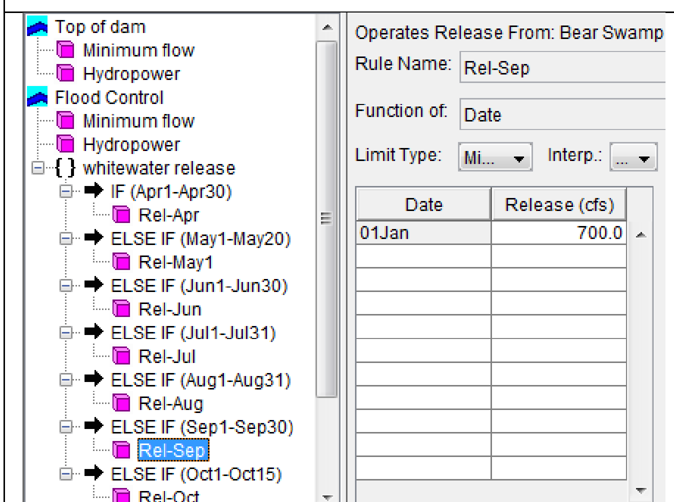

Top of dam
Minimum flow
Hydropower
Flood Control
Minimum flow
Hydropower
{ } whitewater release
IF (Apr1-Apr30)
Rel-Apr
ELSE IF (May1-May20)
Rel-May1
ELSE IF (Jun1-Jun30)
Rel-Jun
ELSE IF (Jul1-Jul31)
Rel-Jul
ELSE IF (Aug1-Aug31)
Rel-Aug
ELSE IF (Sep1-Sep30)
Rel-Sep
ELSE IF (Oct1-Oct15)
Rel-Oct
Operates Release From: Bear Swamp
Rule Name: Rel-Jun
Function of: Date
Limit Type: Mi...
Interp.: ...
Date
Release (cfs)
01Jan
700.0
Time of Day
Multiplier
0000-0100 0.0
0100-0200 0.0
0200-0300 0.0
0300-0400 0.0
0400-0500 0.0
0500-0600 0.0
0600-0700 0.0
0700-0800 0.0
0800-0900 0.0
0900-1000 1.0
1000-1100 1.0
1100-1200 1.0
1200-1300 0.0
1300-1400 0.0
1400-1500 0.0
1500-1600 0.0
1600-1700 0.0
1700-1800 0.0
1800-1900 0.0
1900-2000 0.0
2000-2100 0.0
2100-2200 0.0
2200-2300 0.0
2300-2400 0.0
Day
Multiplier
Sun 1.00
Mon 0.00
Tues 0.00
Wed 1.00
Thurs 1.00
Fri 1.00
Sat 1.00


Top of dam
Minimum flow
Hydropower
Flood Control
Minimum flow
Hydropower
{ } whitewater release
IF (Apr1-Apr30)
Rel-Apr
ELSE IF (May1-May20)
Rel-May1
ELSE IF (Jun1-Jun30)
Rel-Jun
ELSE IF (Jul1-Jul31)
Rel-Jul
ELSE IF (Aug1-Aug31)
Rel-Aug
ELSE IF (Sep1-Sep30)
Rel-Sep
ELSE IF (Oct1-Oct15)
Rel-Oct
Operates Release From: Bear Swamp
Rule Name: Rel-Jul
Function of: Date
Limit Type: Mi...
Interp.: ...
Date
Release (cfs)
01Jan
700.0
Time of Day
Multiplier
0000-0100 0.0
0100-0200 0.0
0200-0300 0.0
0300-0400 0.0
0400-0500 0.0
0500-0600 0.0
0600-0700 0.0
0700-0800 0.0
0800-0900 0.0
0900-1000 1.0
1000-1100 1.0
1100-1200 1.0
1200-1300 0.0
1300-1400 0.0
1400-1500 0.0
1500-1600 0.0
1600-1700 0.0
1700-1800 0.0
1800-1900 0.0
1900-2000 0.0
2000-2100 0.0
2100-2200 0.0
2200-2300 0.0
2300-2400 0.0
Day
Multiplier
Sun 1.00
Mon 0.00
Tues 0.00
Wed 1.00
Thurs 1.00
Fri 1.00
Sat 1.00



Time of Day	Multiplier
0000-0100	0.0
0100-0200	0.0
0200-0300	0.0
0300-0400	0.0
0400-0500	0.0
0500-0600	0.0
0600-0700	0.0
0700-0800	0.0
0800-0900	0.0
0900-1000	1.0
1000-1100	1.0
1100-1200	1.0
1200-1300	0.0
1300-1400	0.0
1400-1500	0.0
1500-1600	0.0
1600-1700	0.0
1700-1800	0.0
1800-1900	0.0
1900-2000	0.0
2000-2100	0.0
2100-2200	0.0
2200-2300	0.0
2300-2400	0.0

Day	Multiplier
Sun	1.00
Mon	0.00
Tues	0.00
Wed	0.00
Thurs	1.00
Fri	1.00
Sat	1.00



Time of Day	Multiplier
0000-0100	0.0
0100-0200	0.0
0200-0300	0.0
0300-0400	0.0
0400-0500	0.0
0500-0600	0.0
0600-0700	0.0
0700-0800	0.0
0800-0900	0.0
0900-1000	1.0
1000-1100	1.0
1100-1200	1.0
1200-1300	0.0
1300-1400	0.0
1400-1500	0.0
1500-1600	0.0
1600-1700	0.0
1700-1800	0.0
1800-1900	0.0
1900-2000	0.0
2000-2100	0.0
2100-2200	0.0
2200-2300	0.0
2300-2400	0.0

Day	Multiplier
Sun	1.00
Mon	0.00
Tues	0.00
Wed	1.00
Thurs	1.00
Fri	1.00
Sat	1.00

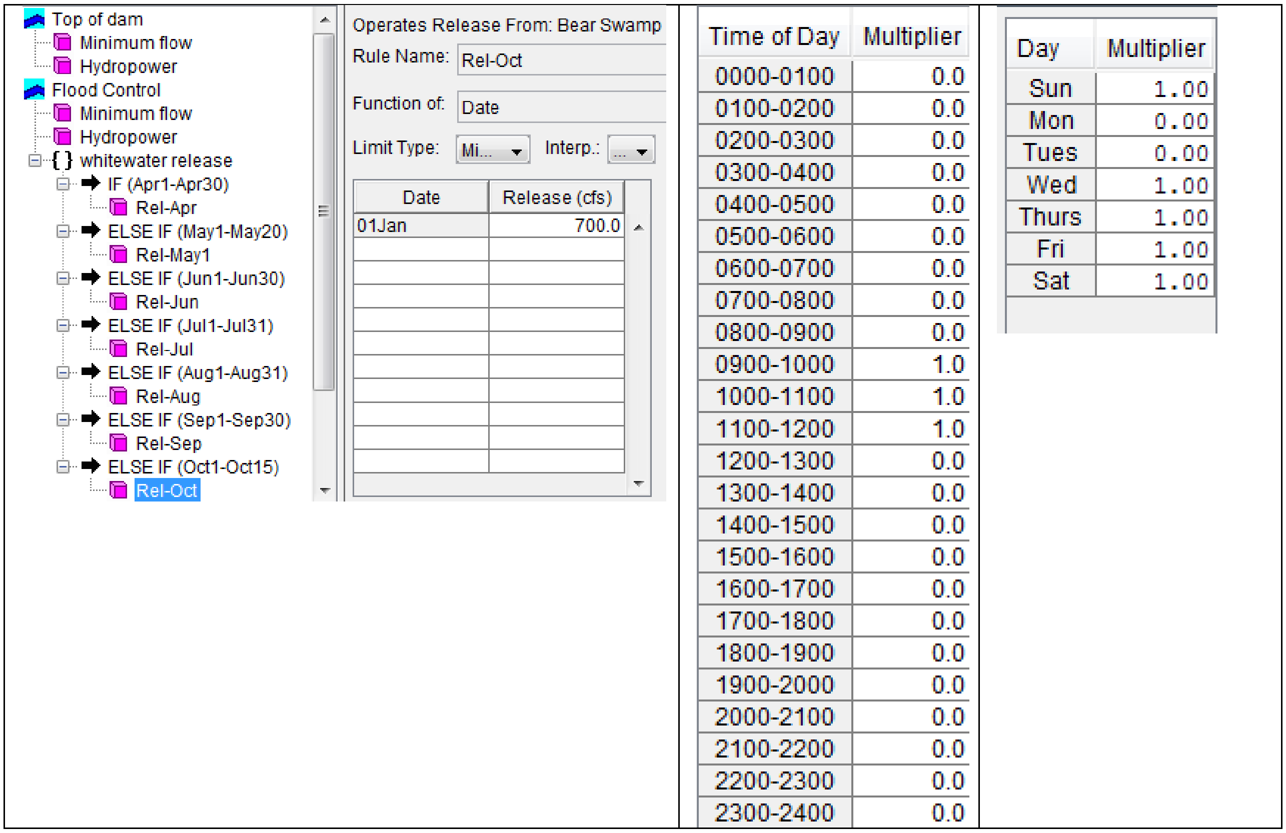


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet –Whitewater release

Bellows Falls

I. Overview

Bellows Falls dam is located on the mainstem Connecticut River in the towns of Rockingham, VT and Walpole, NH. It is owned and operated by TransCanada Hydro Northeast Inc. for hydropower generation on a run-of-river basis.

Figure 1 shows the location of Bellows Falls dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Bellows Falls dam.

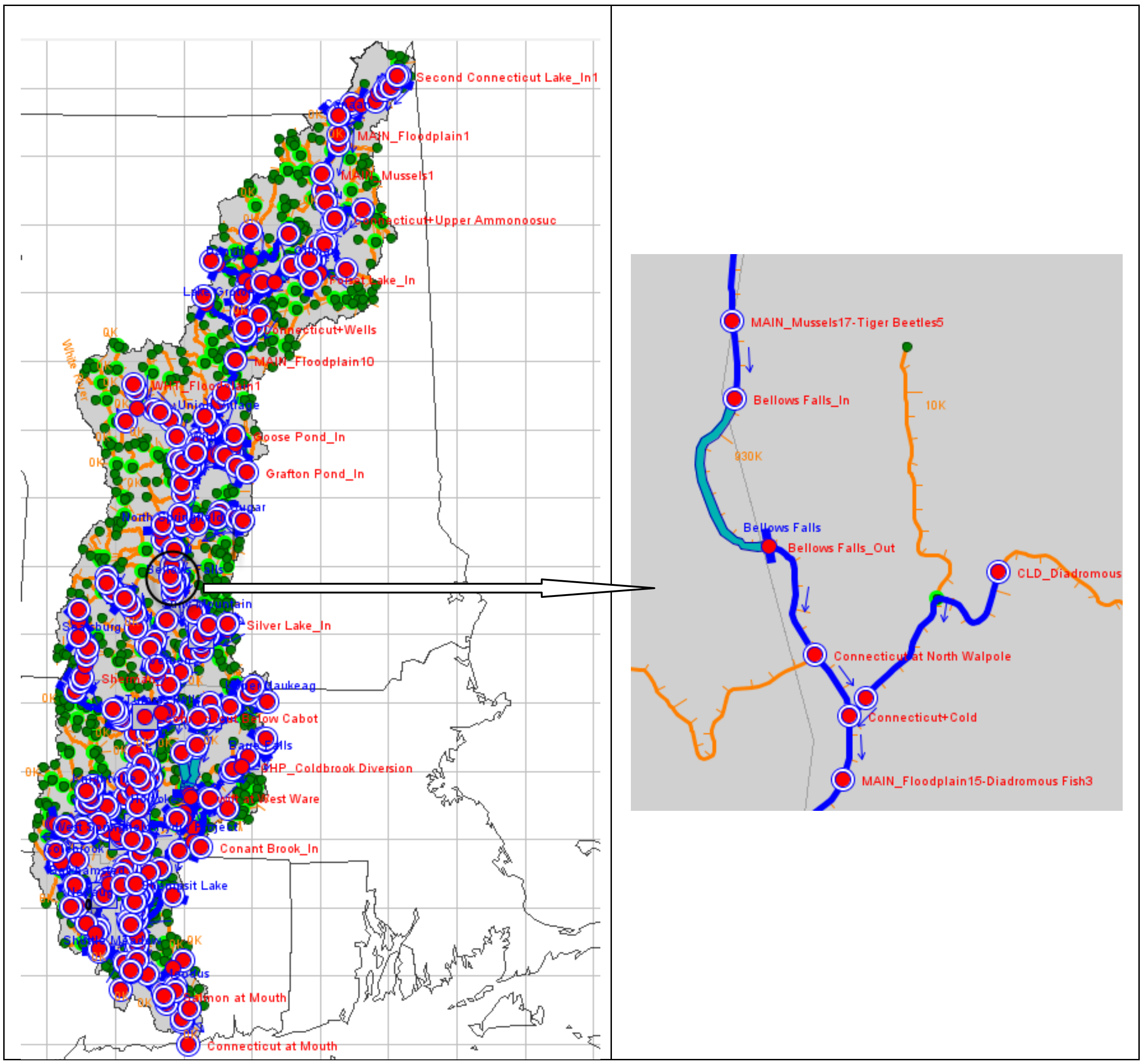


Figure 1: HEC-ResSim Map Display Showing Location of Bellows Falls dam

Figure 2: Photo of Bellows Falls dam.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[8]. The dam consists of seven types of outlets: (1) controlled Roller gate, and (2) uncontrolled 121 ft Bay-w flashboards, (3) uncontrolled 100 ft Bay-w flashboards, (4) uncontrolled Stanchion-w flashboards, (5) controlled Fish Ladder, (6) Downstream Fish Passage, and (7) power plant as shown in Figure 4.

[8] Data provided by TransCanada

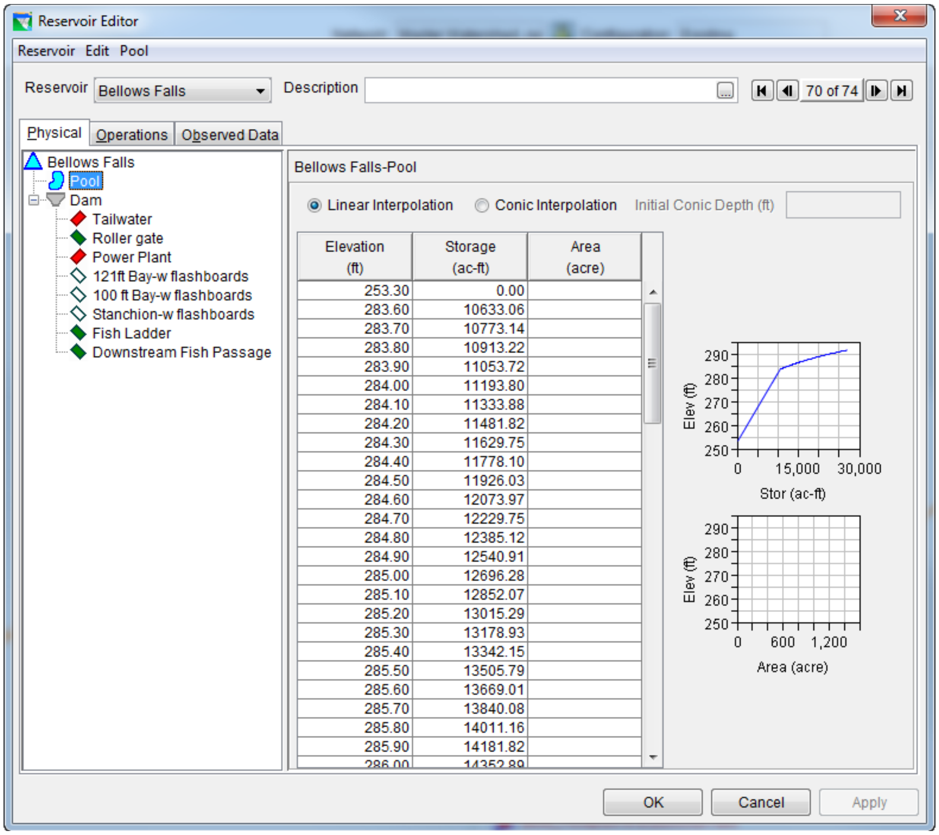


Figure 3: Reservoir Editor: Physical Tab -- Pool

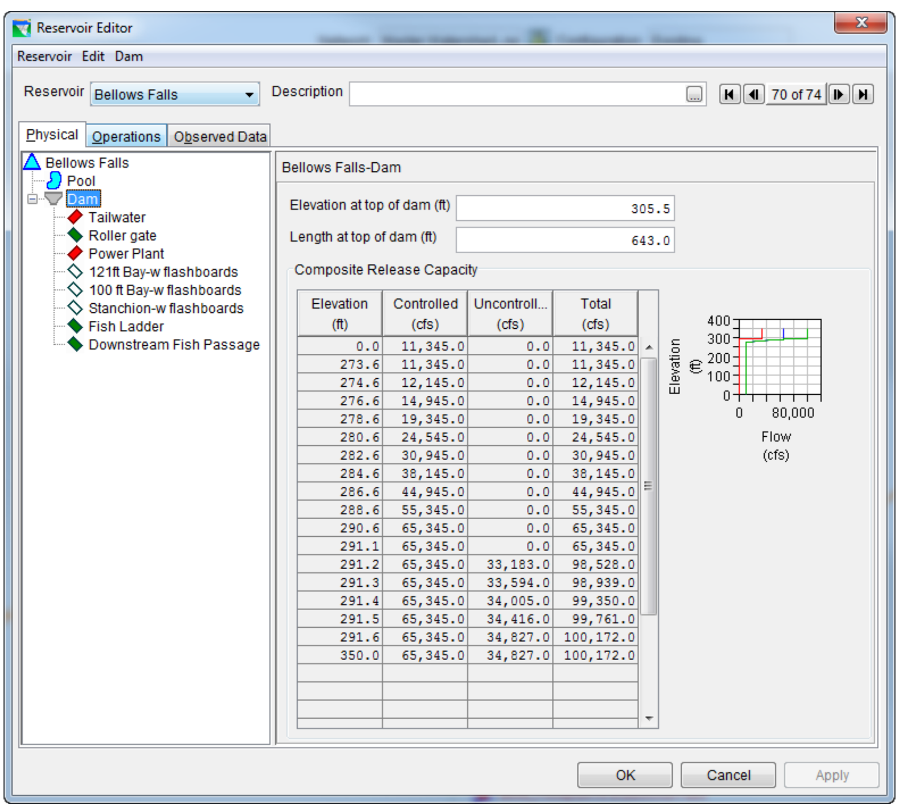


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Bellows Falls's "Existing Ops" operational zones, which consist of zones of Flood Control (305.5 ft), FERC Max Pool (291.6 ft), Conservation (291.1 ft), Buffer (289.9 ft), and Inactive zone (288.6 ft)[1].

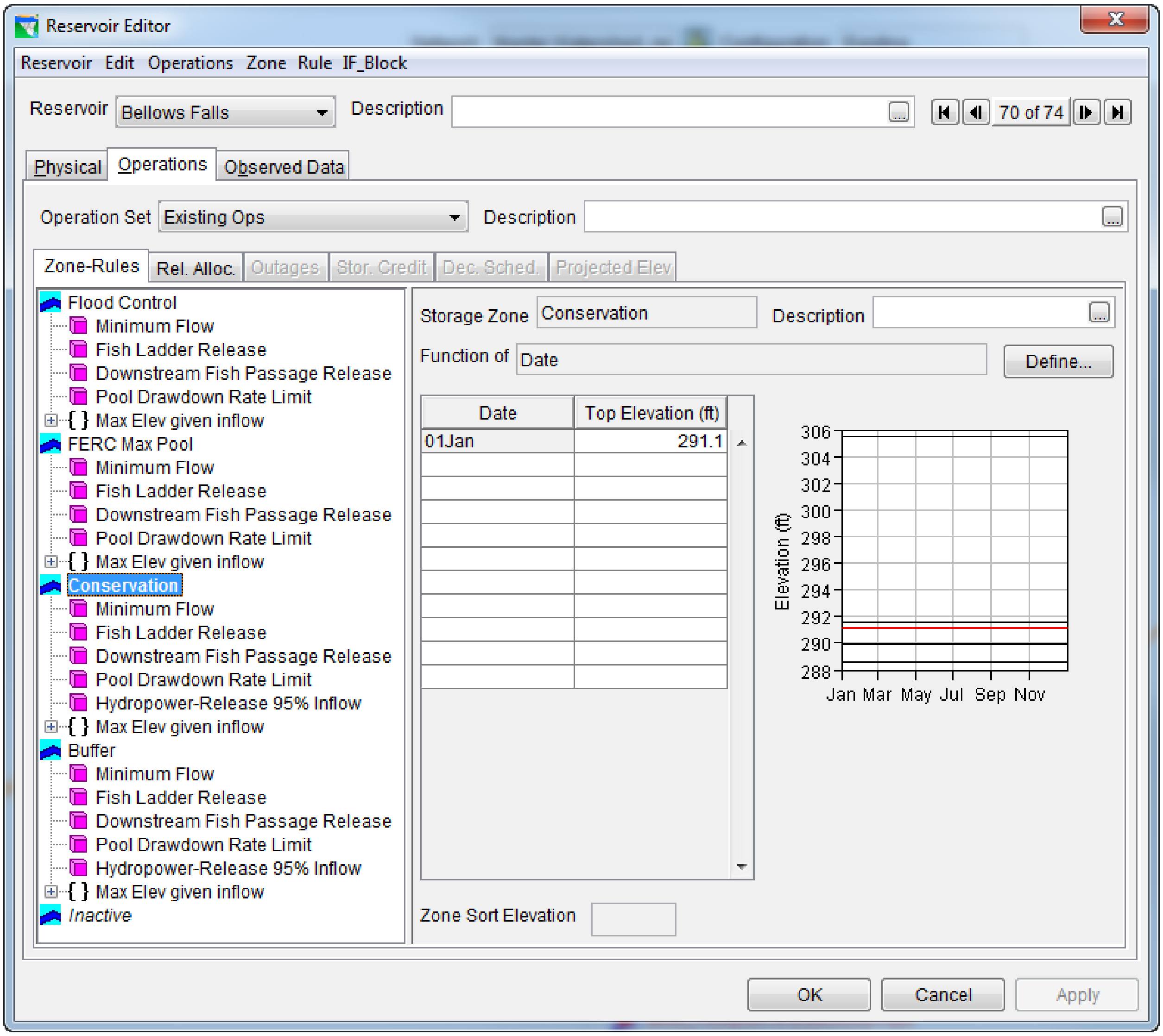


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Bellows Falls Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The Roller gate gets the remainder of the release until it reaches capacity. After the capacity through the Roller gate is reached, the remainder of the release goes through the Fish ladder gate and Downstream Fish Passage, respectively.

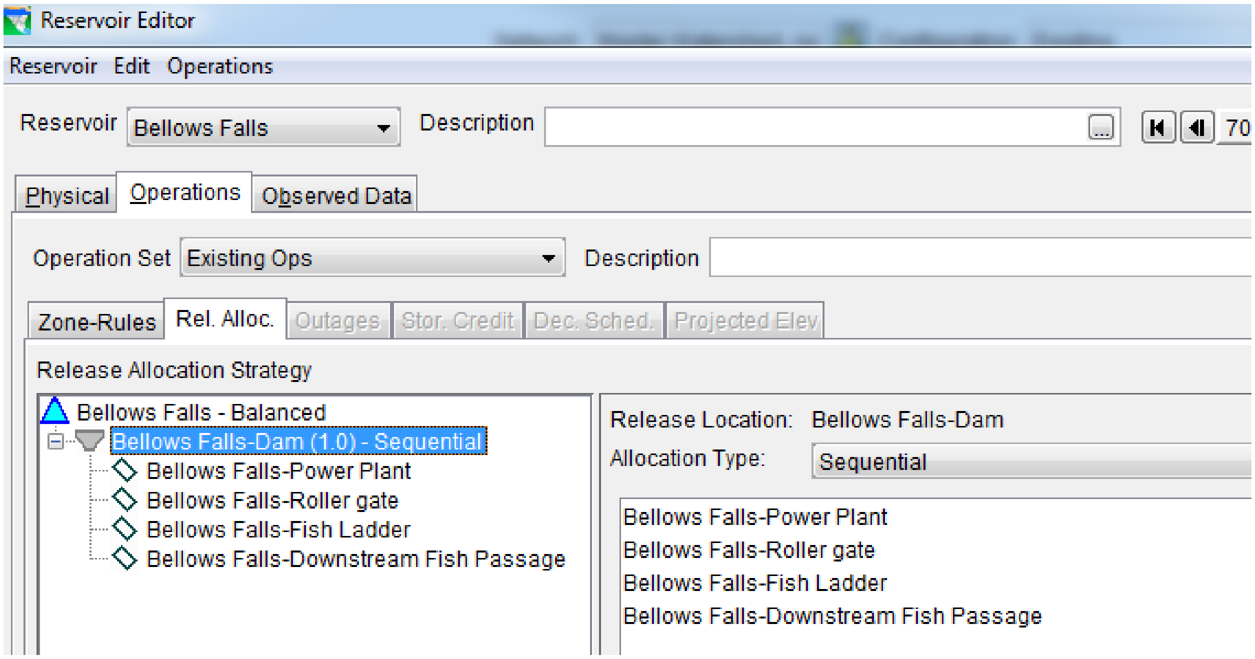


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[9].

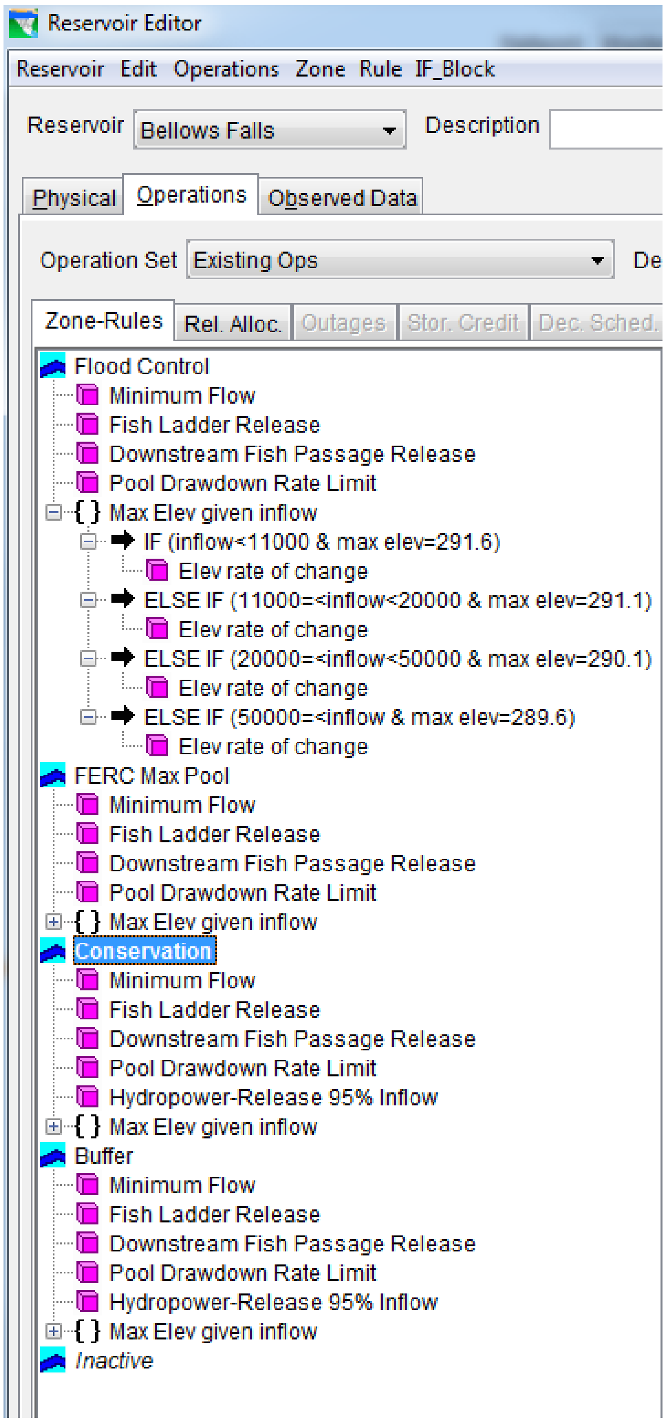


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[9] TransCanada. Connecticut River Operational Constraints. 2012.

C. Rule Descriptions

1. Minimum Flow

Figure 8 shows the content of “Minimum Flow” rule. This rule represents the minimum release from dam as a function of flow.

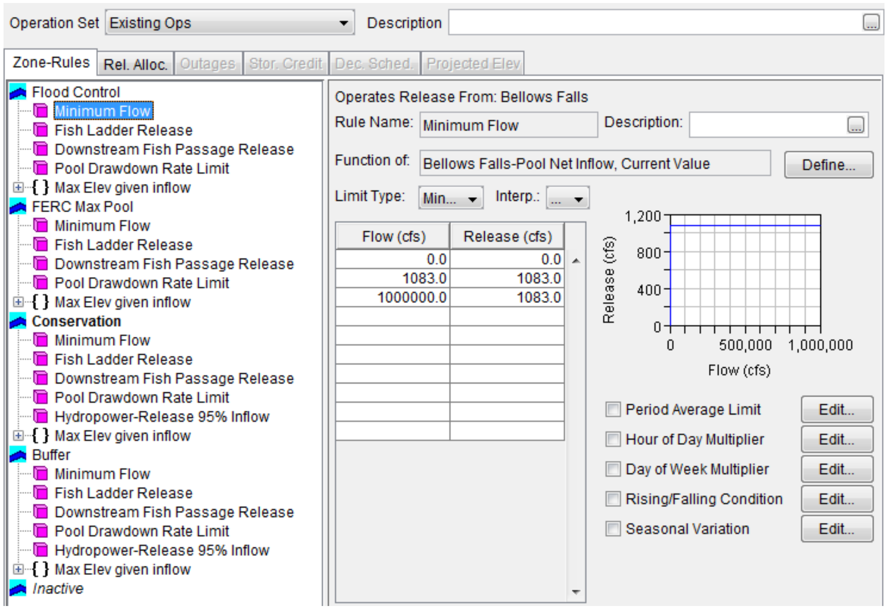


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Minimum Flow

2. Fish Ladder Release

Figure 9 shows the content of “Fish Ladder Release” rule. This rule shows the specified release from a fish ladder controlled outlet.

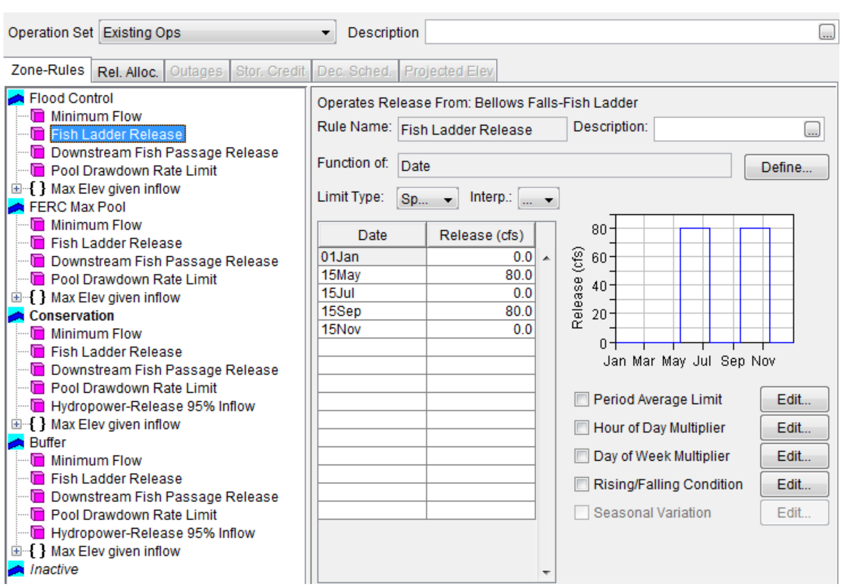


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Fish Ladder Release

3. *Downstream Fish Passage Release*

Figure 10 shows the content of "Downstream Fish Passage Release" rule. This rule shows the specified release from a Downstream Fish Passage controlled outlet.

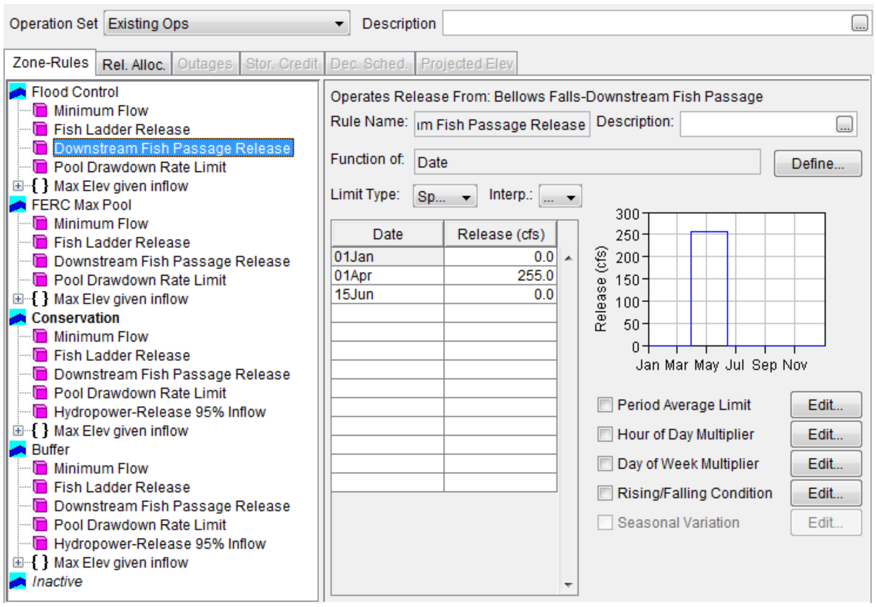


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Downstream Fish Passage Relaese

4. *Pool Drawdown Rate Limit*

Figure 11 shows the content of "Pool Drawdown Rate Limit" rule. This rule describes the maximum elevation rate of change.

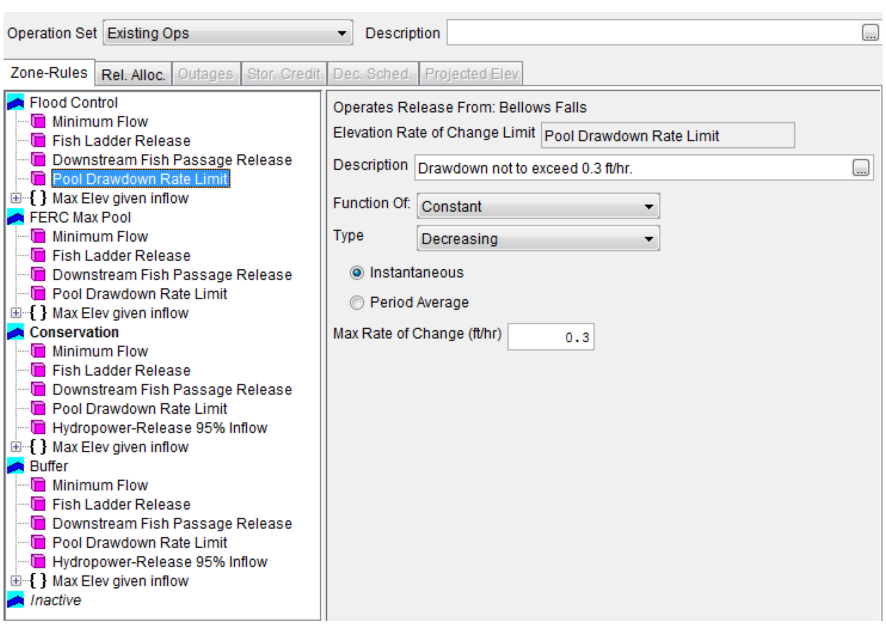
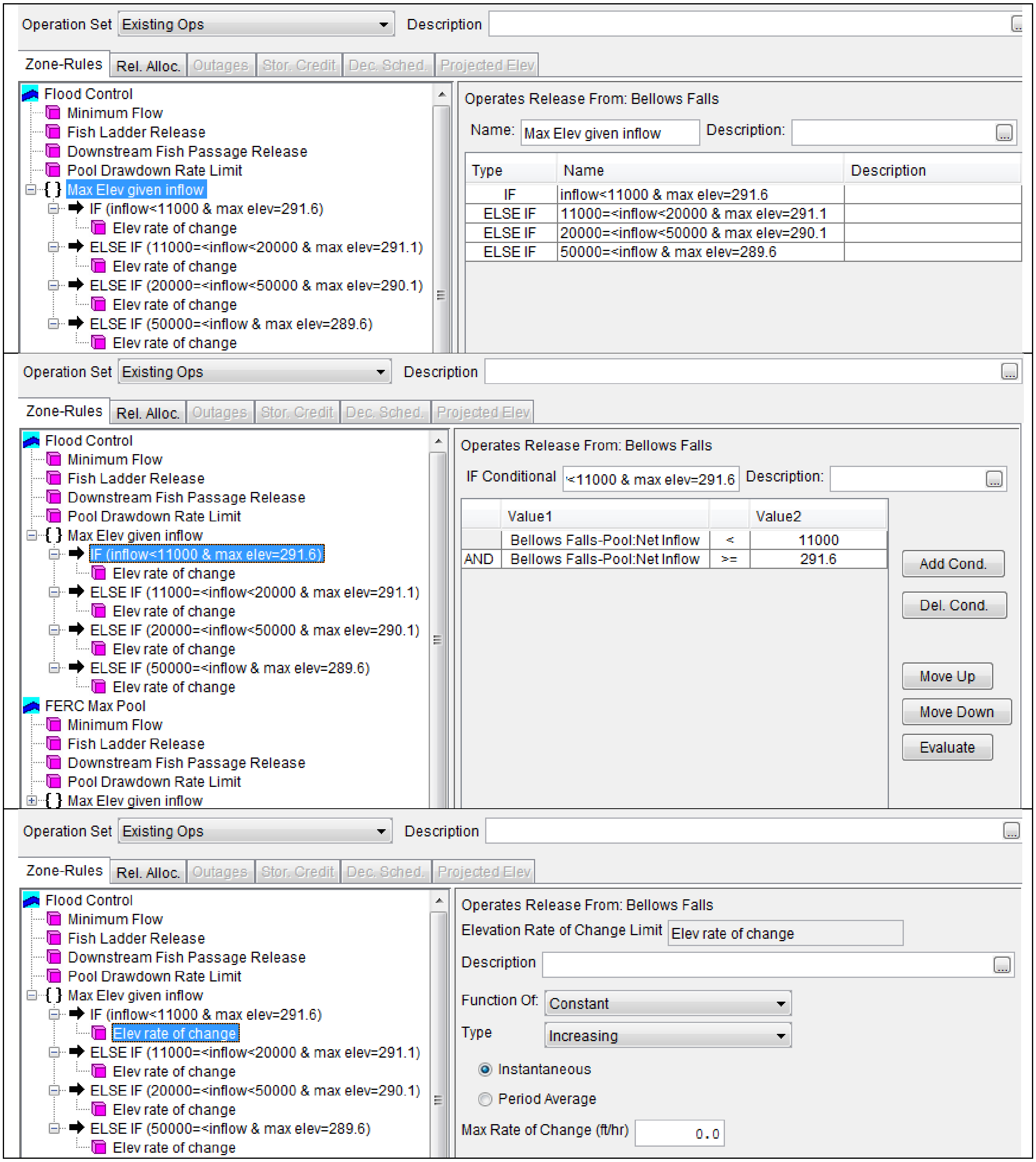
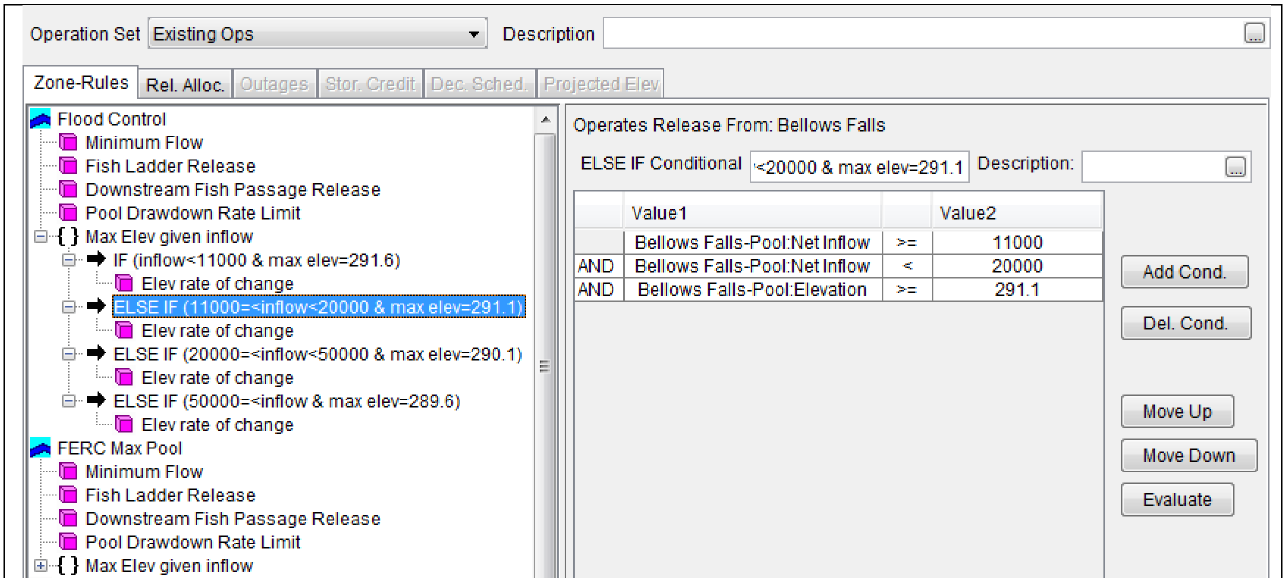


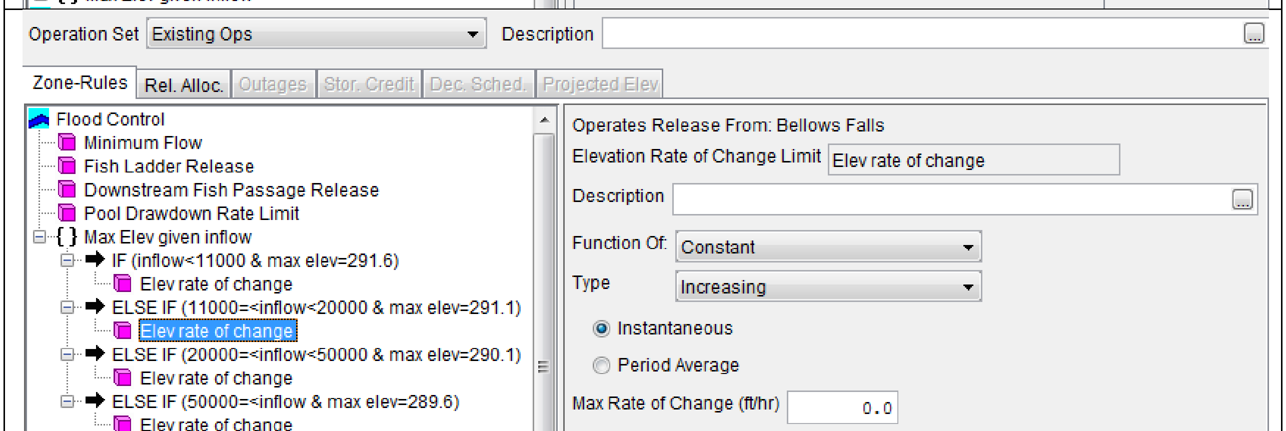
Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Pool Drawdown Rate Limit

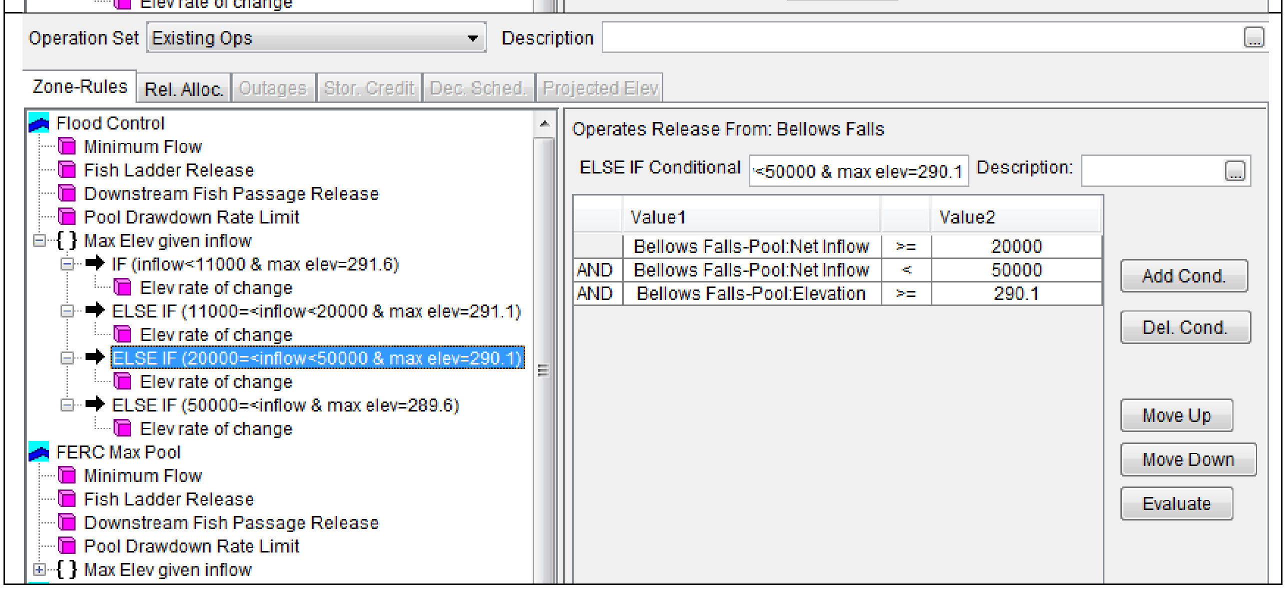
5. *Max Elev given Inflow*

Figure 12 shows the content of "Max Elev given Inlow" rule. This rule shows the maximum elevation rate of change for different range of inflow.




Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Flood Control
Minimum Flow
Fish Ladder Release
Downstream Fish Passage Release
Pool Drawdown Rate Limit
{ } Max Elev given inflow
IF (inflow<11000 & max elev=291.6)
Elev rate of change
ELSE IF (11000=<inflow<20000 & max elev=291.1)
Elev rate of change
ELSE IF (20000=<inflow<50000 & max elev=290.1)
Elev rate of change
ELSE IF (50000=<inflow & max elev=289.6)
Elev rate of change
FERC Max Pool
Minimum Flow
Fish Ladder Release
Downstream Fish Passage Release
Pool Drawdown Rate Limit
{ } Max Elev given inflow
Operates Release From: Bellows Falls
ELSE IF Conditional
<20000 & max elev=291.1
Description:
Value1
Value2
Bellows Falls-Pool:Net Inflow >= 11000
AND Bellows Falls-Pool:Net Inflow < 20000
AND Bellows Falls-Pool:Elevation >= 291.1
Add Cond.
Del. Cond.
Move Up
Move Down
Evaluate


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Flood Control
Minimum Flow
Fish Ladder Release
Downstream Fish Passage Release
Pool Drawdown Rate Limit
{ } Max Elev given inflow
IF (inflow<11000 & max elev=291.6)
Elev rate of change
ELSE IF (11000=<inflow<20000 & max elev=291.1)
Elev rate of change
ELSE IF (20000=<inflow<50000 & max elev=290.1)
Elev rate of change
ELSE IF (50000=<inflow & max elev=289.6)
Elev rate of change
Operates Release From: Bellows Falls
Elevation Rate of Change Limit
Elev rate of change
Description
Function Of: Constant
Type Increasing
Instantaneous
Period Average
Max Rate of Change (ft/hr)
0.0


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Flood Control
Minimum Flow
Fish Ladder Release
Downstream Fish Passage Release
Pool Drawdown Rate Limit
{ } Max Elev given inflow
IF (inflow<11000 & max elev=291.6)
Elev rate of change
ELSE IF (11000=<inflow<20000 & max elev=291.1)
Elev rate of change
ELSE IF (20000=<inflow<50000 & max elev=290.1)
Elev rate of change
ELSE IF (50000=<inflow & max elev=289.6)
Elev rate of change
FERC Max Pool
Minimum Flow
Fish Ladder Release
Downstream Fish Passage Release
Pool Drawdown Rate Limit
{ } Max Elev given inflow
Operates Release From: Bellows Falls
ELSE IF Conditional
<50000 & max elev=290.1
Description:
Value1
Value2
Bellows Falls-Pool:Net Inflow >= 20000
AND Bellows Falls-Pool:Net Inflow < 50000
AND Bellows Falls-Pool:Elevation >= 290.1
Add Cond.
Del. Cond.
Move Up
Move Down
Evaluate

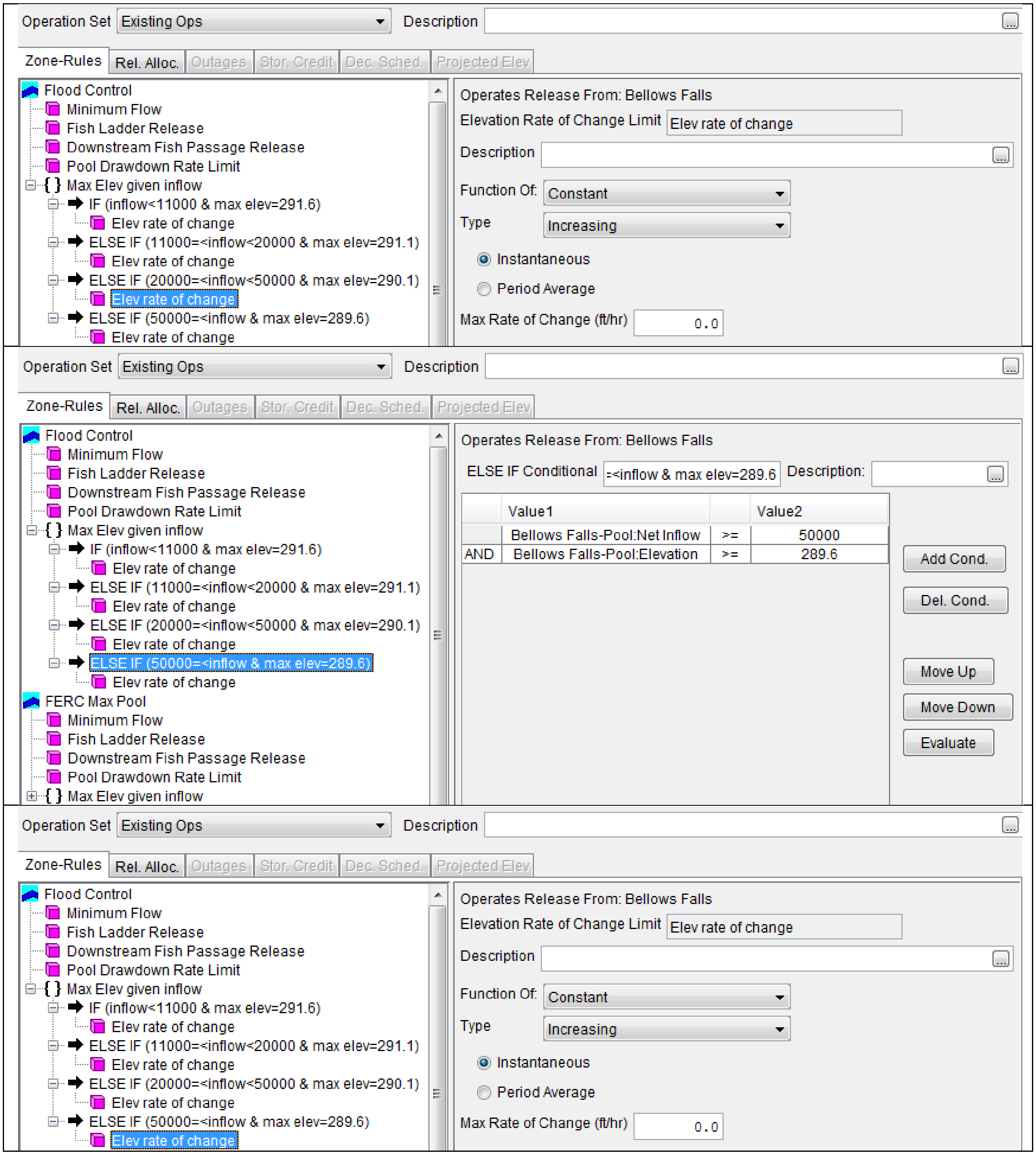


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Elev given Inflow

6. Hydropower-Release 95% Inflow

Figure 13 shows the content of "Hydropower-Release 95% Inflow" rule. This rule releases 95% of inflow through power plant as per the run-of-river modeling strategy.

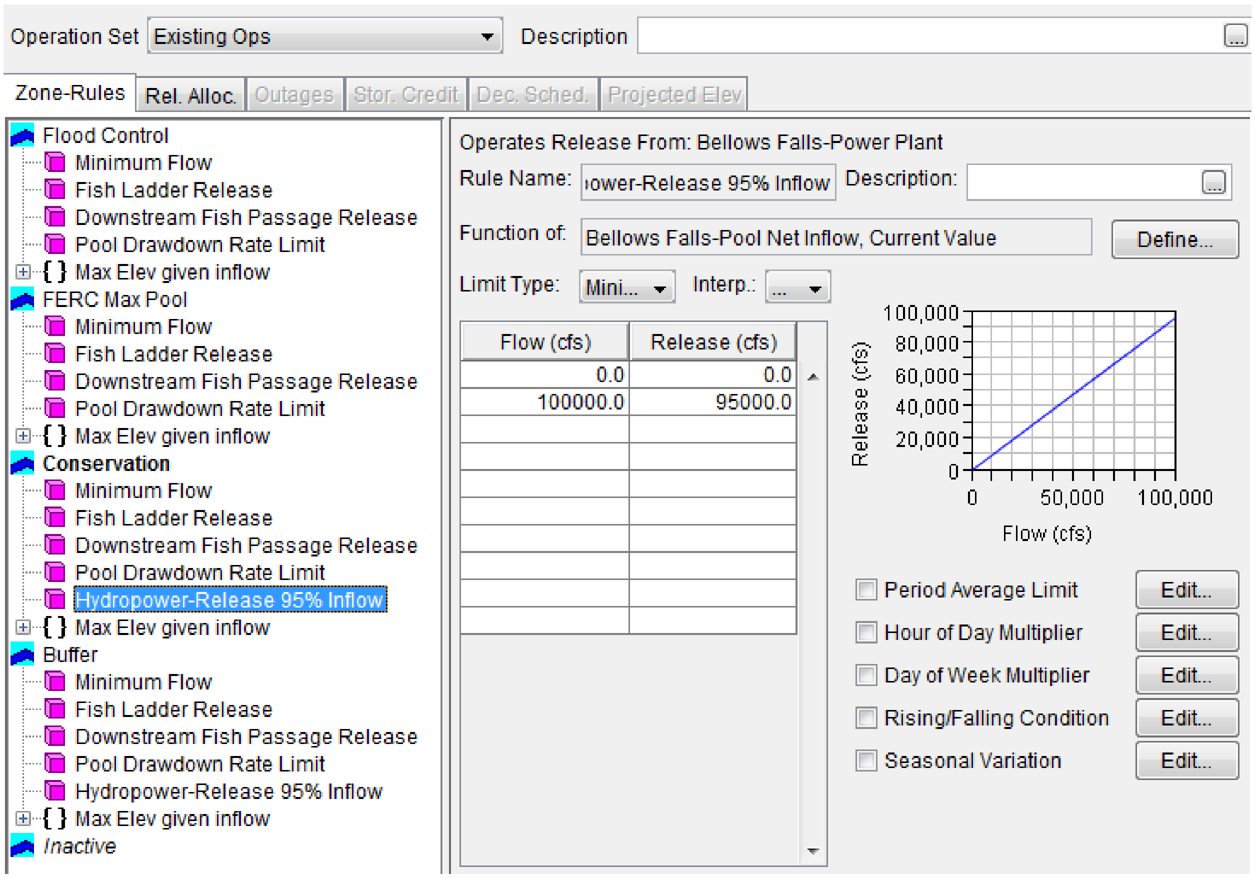


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Hydropower-Release 95% Inflow

Bickford

I. Overview

Bickford dam is a dam on the Ware River by Worcester, MA. Construction of the reservoir was completed in 1970 and the dam is owned by the City of Fitchburg, which uses it for water supply for the city. .

Figure 1 shows the location of Bickford Dam as it is represented in the HEC-ResSim model. Figure 2 shows a view from the dam.

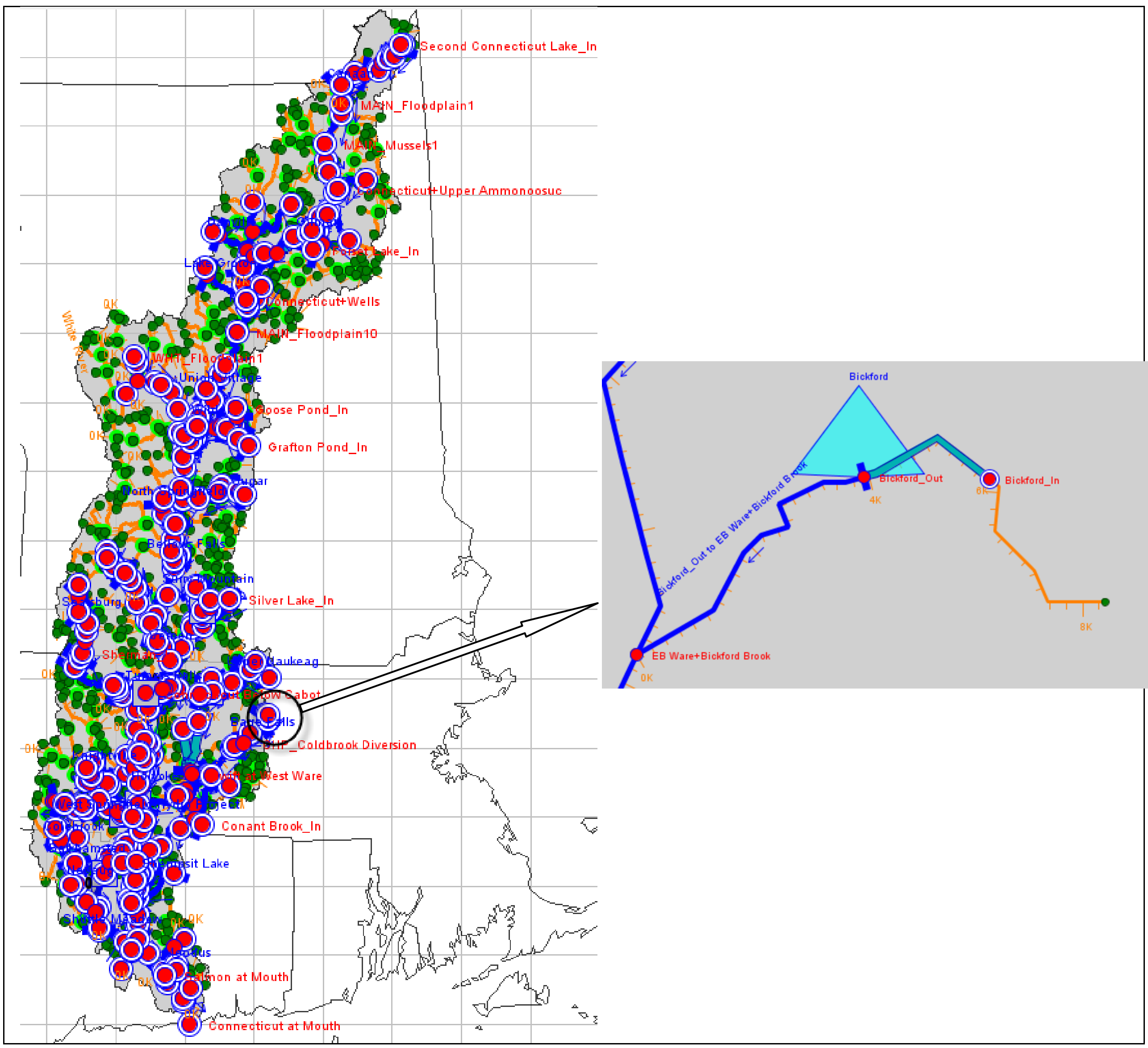


Figure 1: HEC-ResSim Map Display Showing Location of Bickford

Figure 2: View from Bickford Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[10]. The dam consists of a controlled outlet and an uncontrolled spillway as shown in Figure 4.

[10] Bickford Dam Phase 1 Report: 1980

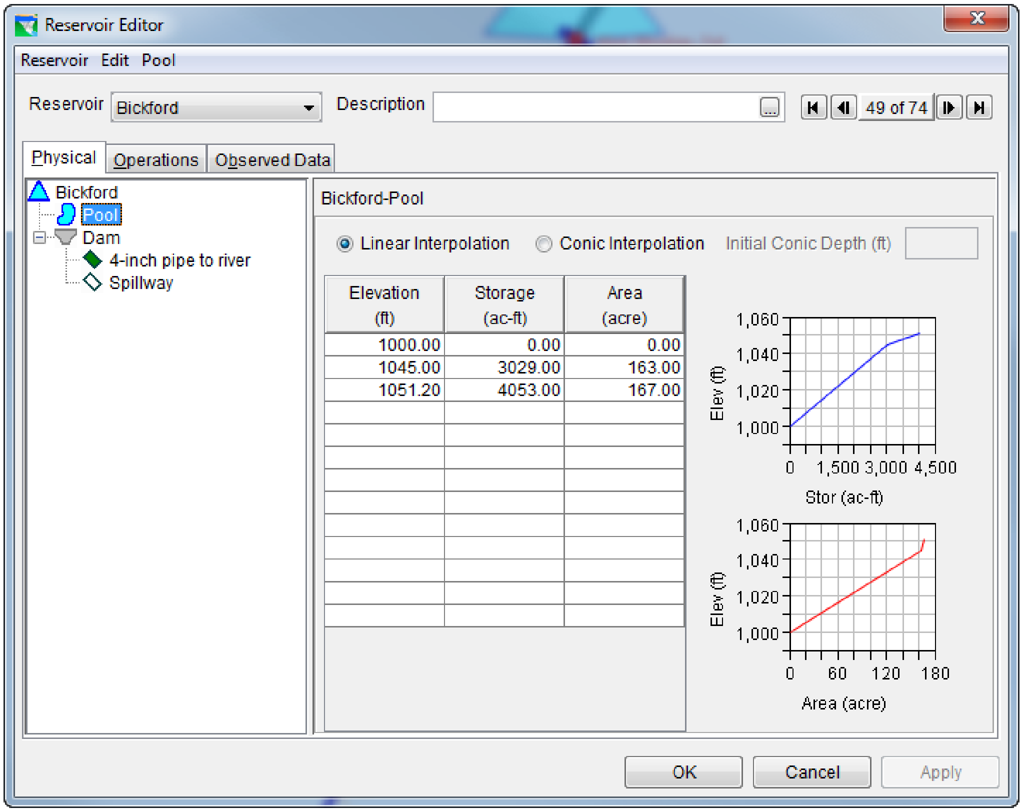


Figure 3: Reservoir Editor -- Physical Tab -- Pool

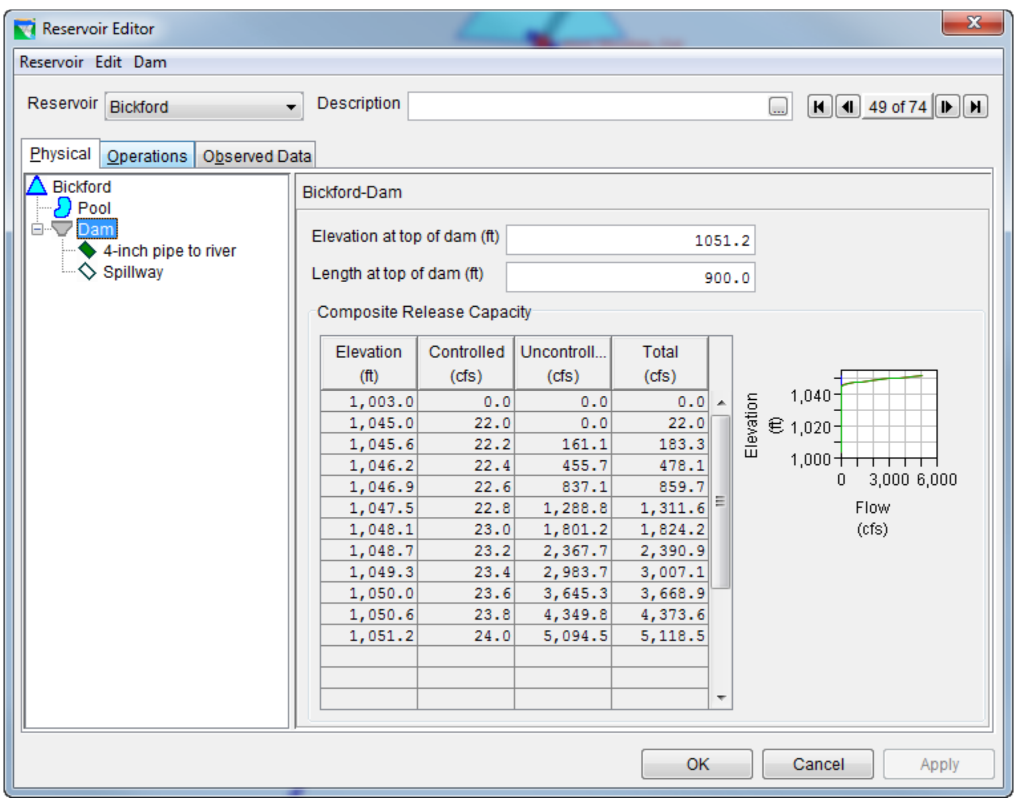


Figure 4: Reservoir Editor -- Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Bickford's "Existing Ops" operational zones, which consist of the zones Flood Control (1051.2 ft), Conservation (1045 ft), and Inactive (1000 ft)[1].

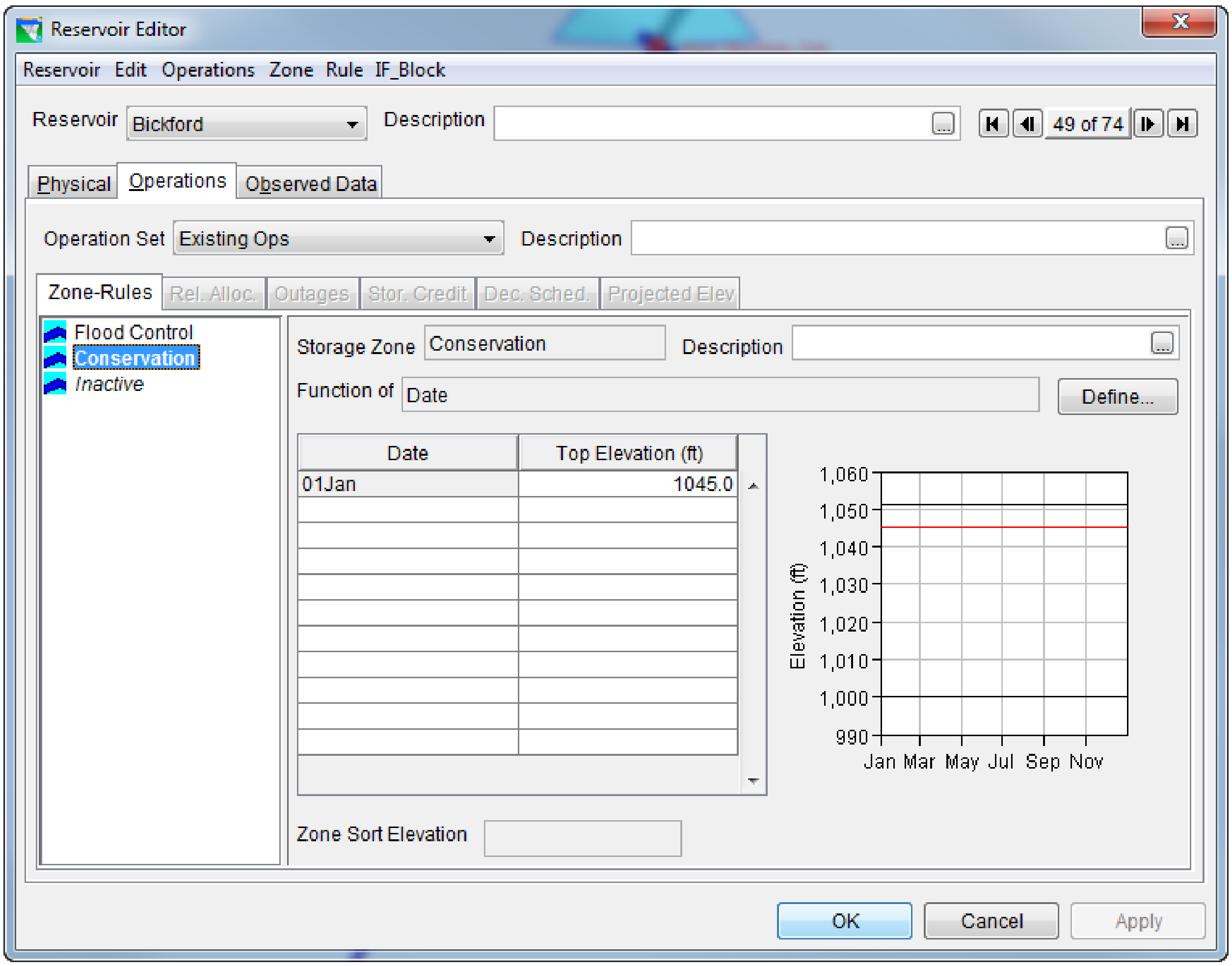


Figure 5: Reservoir Editor -- Operations Tab – Existing Ops OpSet

B. Rule Illustrations

The operation set for Bickford has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity. There is a water supply timeseries for Bickford that is described in the water supply section of the report.

Birch Hill

I. Overview

Birch Hill is a dam on the Millers River upstream of Athol. Constructed in 1941 by the US Army Corps of Engineers, it is still owned and operated by the Corps. It is primarily used for flood control but is also used for recreation.

Figure 1 shows the location of Birch Hill Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the dam.

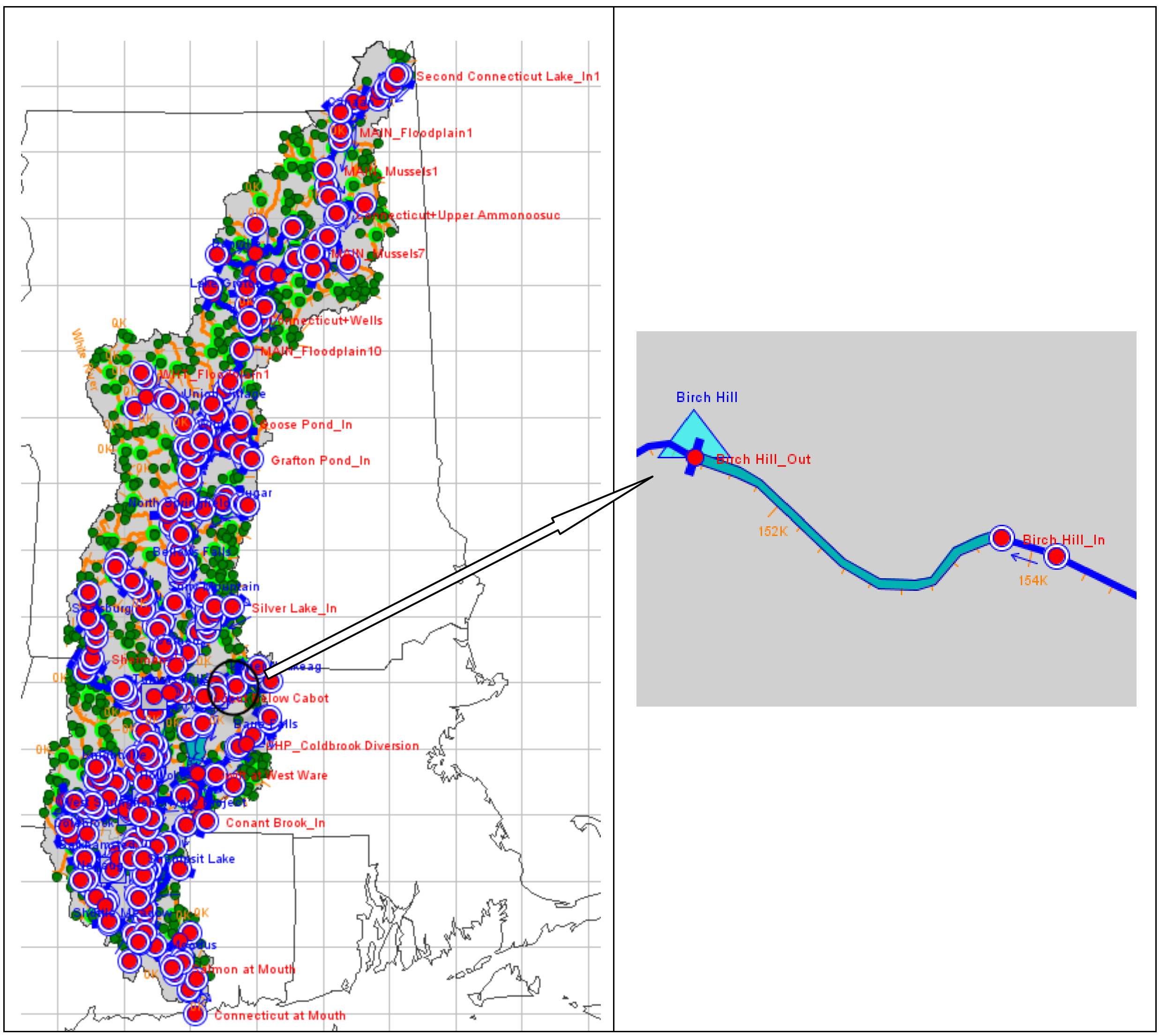


Figure 1: HEC-ResSim Map Display Showing Location of Birch Hill dam

Figure 2: Photo of Birch Hill dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled slide gates, and (2) uncontrolled spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[11].

[11] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

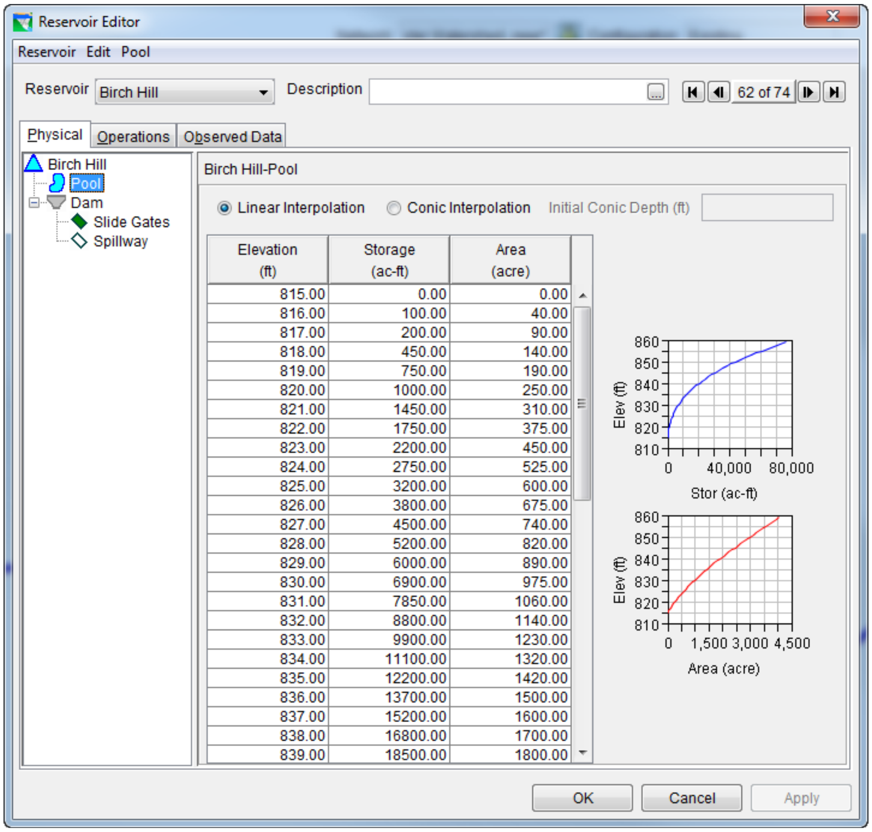


Figure 3: Reservoir Editor: Physical Tab -- Pool

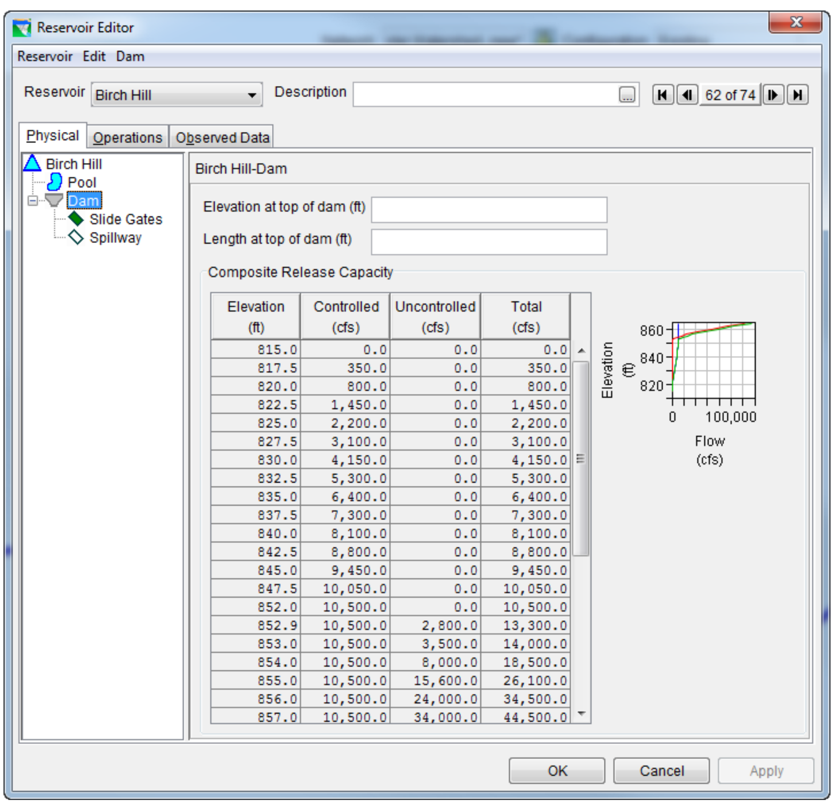


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Birch Hill's "ExistingOps" operational zones, which consist of zones of Excess Surcharge (864 ft), Surcharge Storage (854 ft), Flood Control (852 ft), Conservation (816-825 ft), and Inactive zone (815 ft).

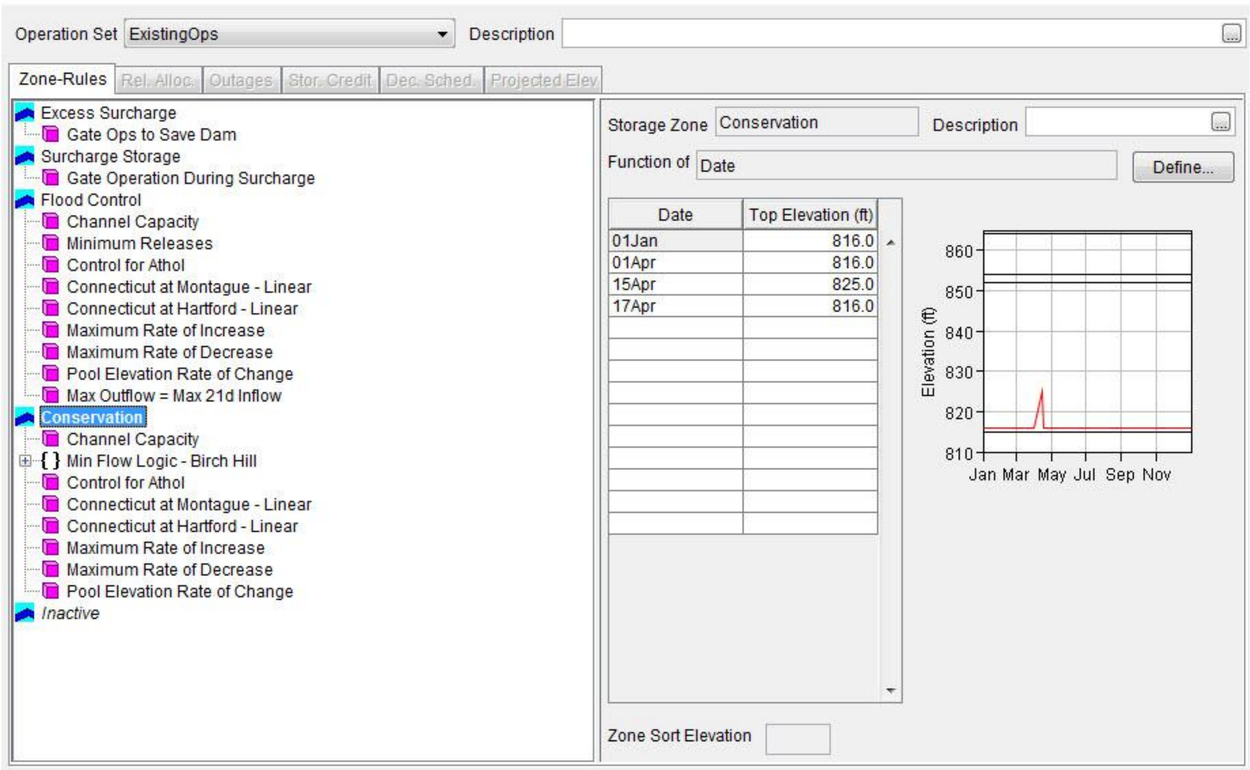


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named ExistingOps. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

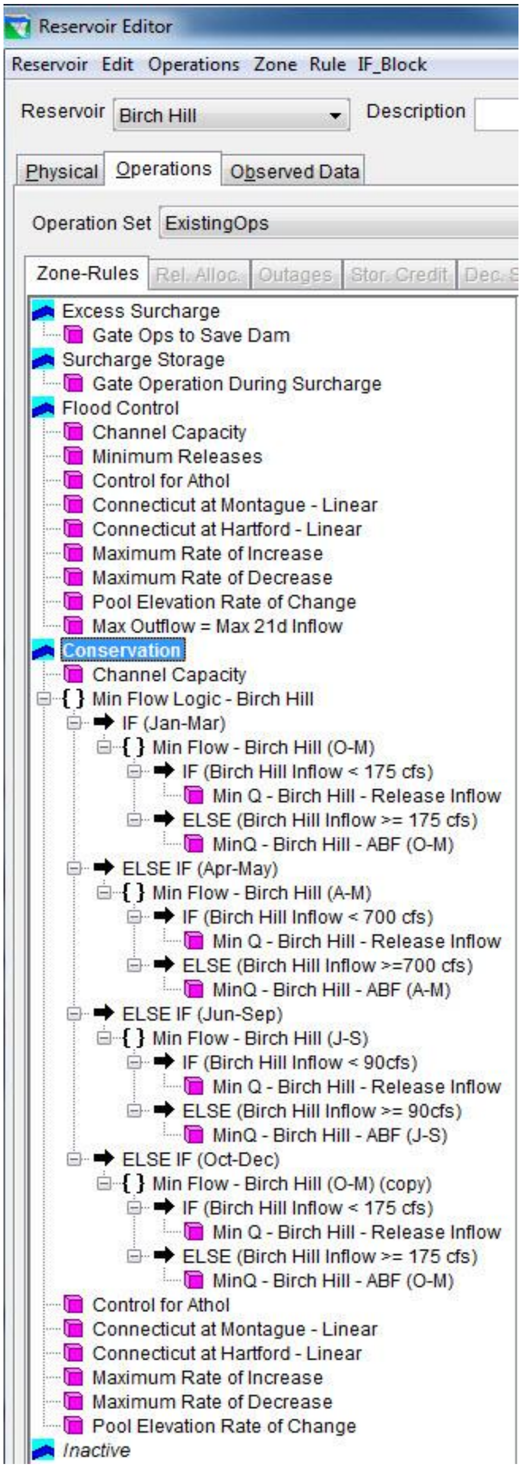


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Gate Ops to Save Dam

Figure 7 shows the content of “Gate Ops to Save Dam” rule. This rule represents the maximum allowable release from Slide gates when the pool is in Excess Surcharge zone as a function of pool elevation.

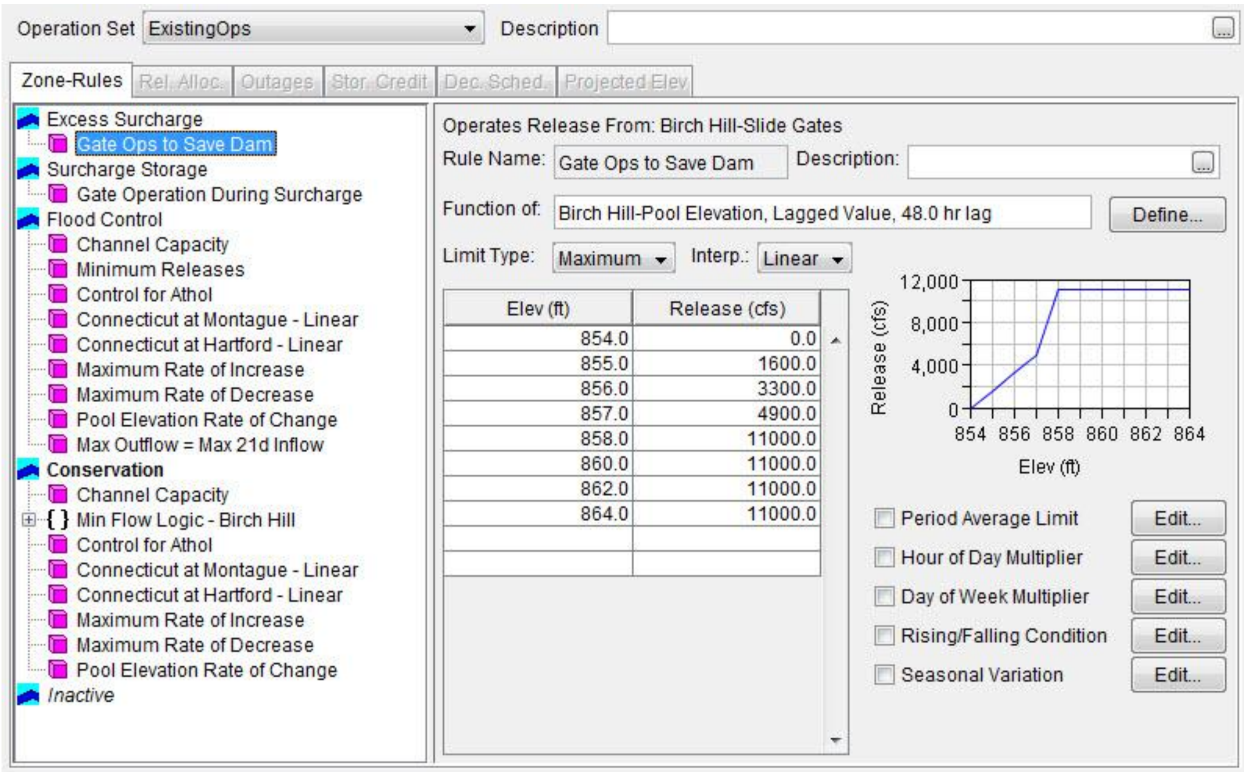


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet –Gate Ops to Save Dam

2. Gate Operation During Surcharge

Figure 8 shows the content of "Gate Operation During Surcharge" rule. This rule represents the maximum allowable release from Birch Hill when the pool is in surcharge Storage zone as a function of pool elevation.

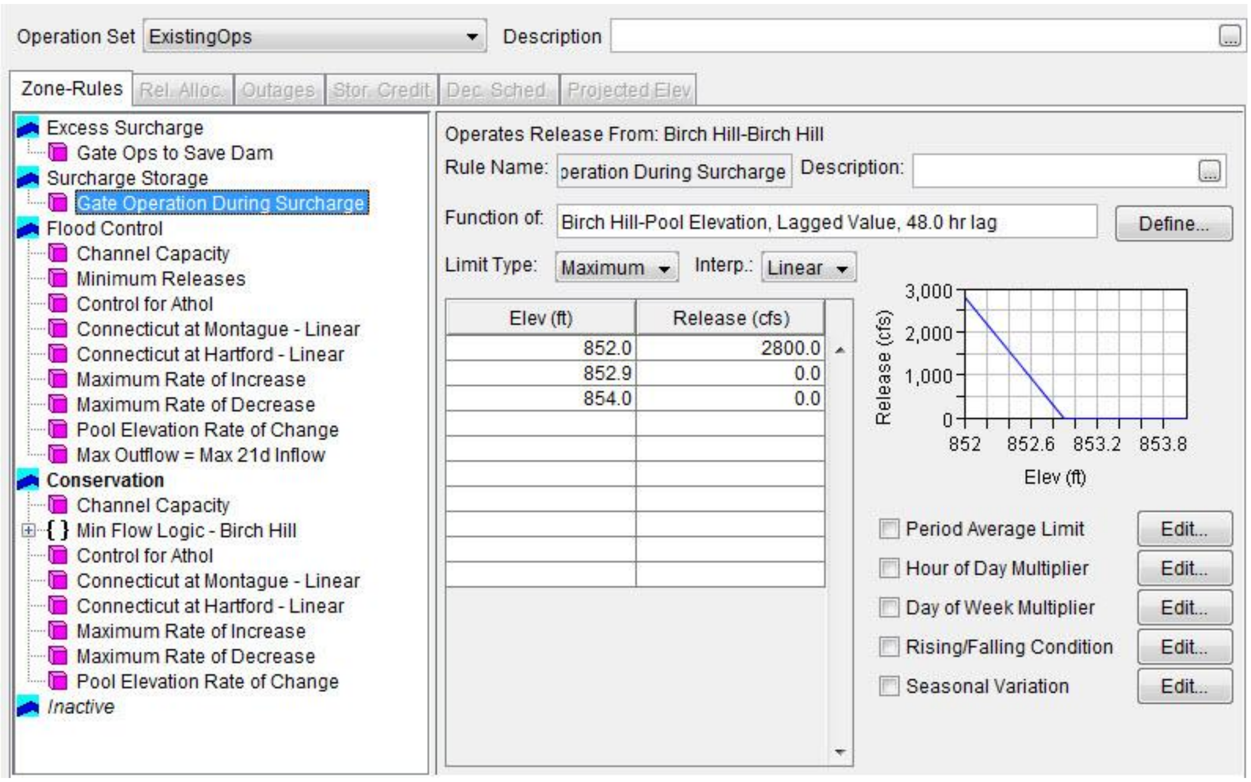


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet –Gate Operation During Surcharge

3. *Channel Capacity*

Figure 9 shows the content of “Channel Capacity” rule. This rule assigns 2000 cfs as a maximum channel capacity.

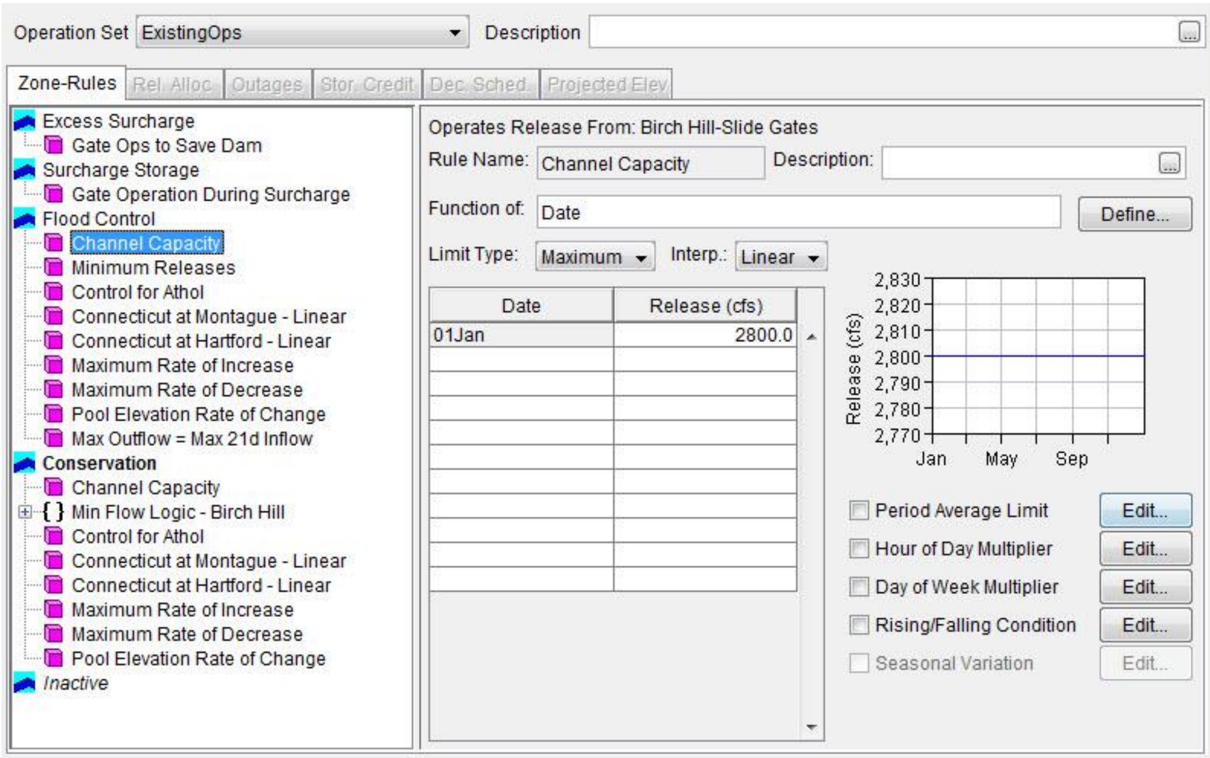


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet –Channel Capacity

4. Minimum Releases

Figure 10 shows the content of "Minimum Releases" rule. This rule shows the minimum required release of 90 cfs from the dam during flood control operations.

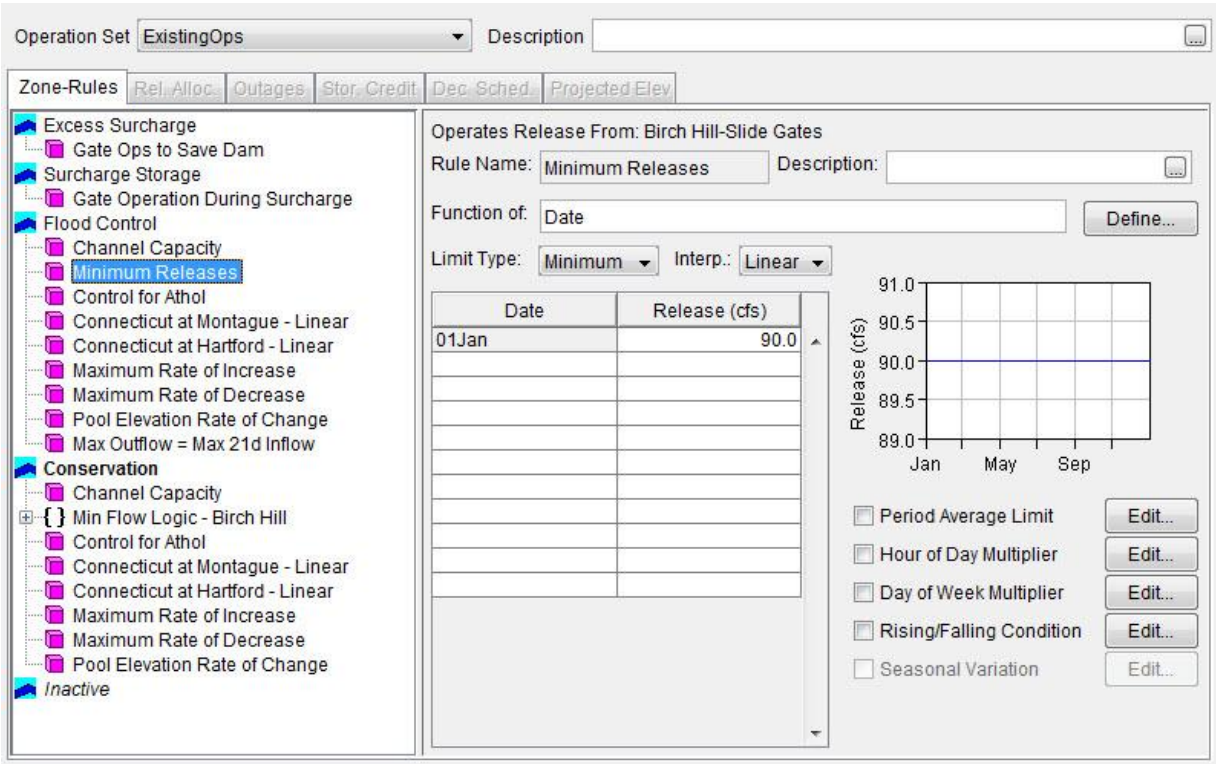


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet –Minimum Releases

5. *Control for Athol*

Figure 11 shows the content of "Control for Athol" rule. This rule represents the maximum release from the dam as a function of stage at Athol over the previous four days. This rule was taken from a previously created ResSim model of Birch Hill dam.

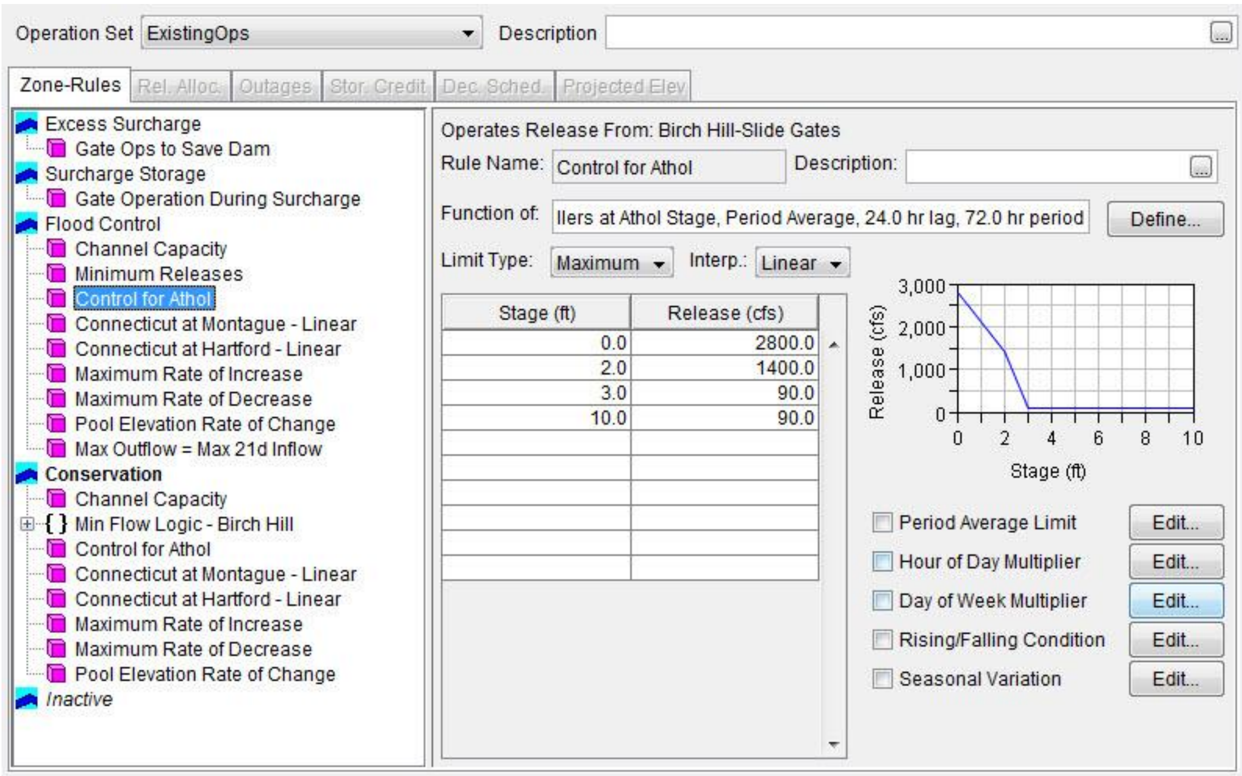
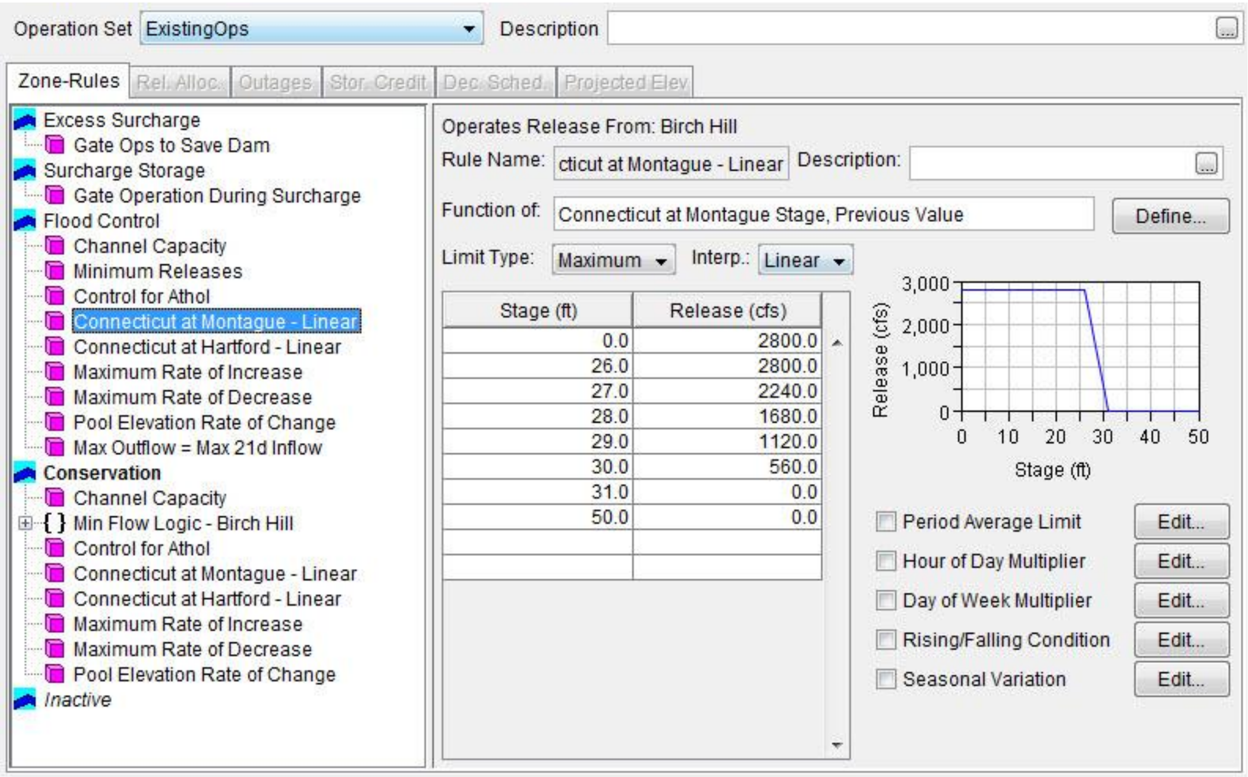


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet –Control for Athol

6. *Connecticut at Montague – Linear*

Figure 12 shows the content of “Connecticut at Montague-Linear” rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montague. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.



Stage (ft)	Release (cfs)
0.0	2800.0
26.0	2800.0
27.0	2240.0
28.0	1680.0
29.0	1120.0
30.0	560.0
31.0	0.0
50.0	0.0

Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague – Linear

7. *Connecticut at Hartford – Linear*

Figure 13 shows the content of "Connecticut at Montague-Linear" rule. This rule represents the maximum allowable release from dam as a function of previous day stage at Hartford. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

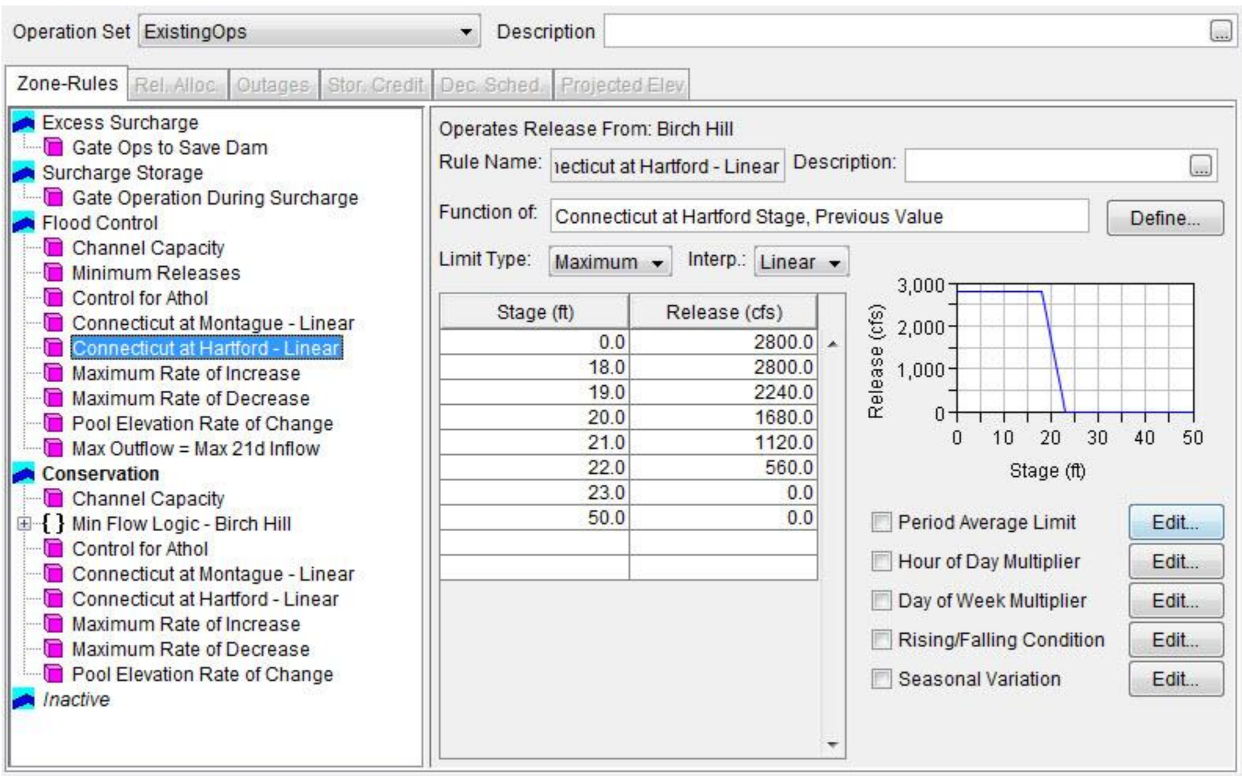


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Hartford - Linear

8. *Maximum Rate of Increase*

Figure 14 shows the content of "Maximum Rate of Increase" rule. This rule shows the increasing maximum allowable release rate of change rule as a function of release from Birch Hill dam.

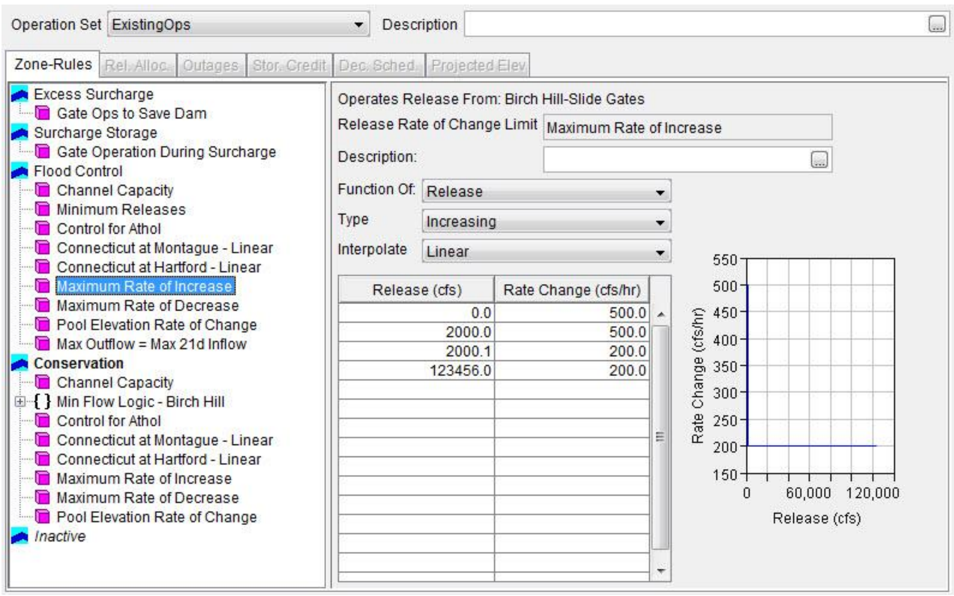


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maximum Rate of Increase

9. *Maximum Rate of Decrease*

Figure 15 shows the content of "Maximum Rate of Decrease" rule. This rule shows the maximum allowable decreasing release rate of change rule.

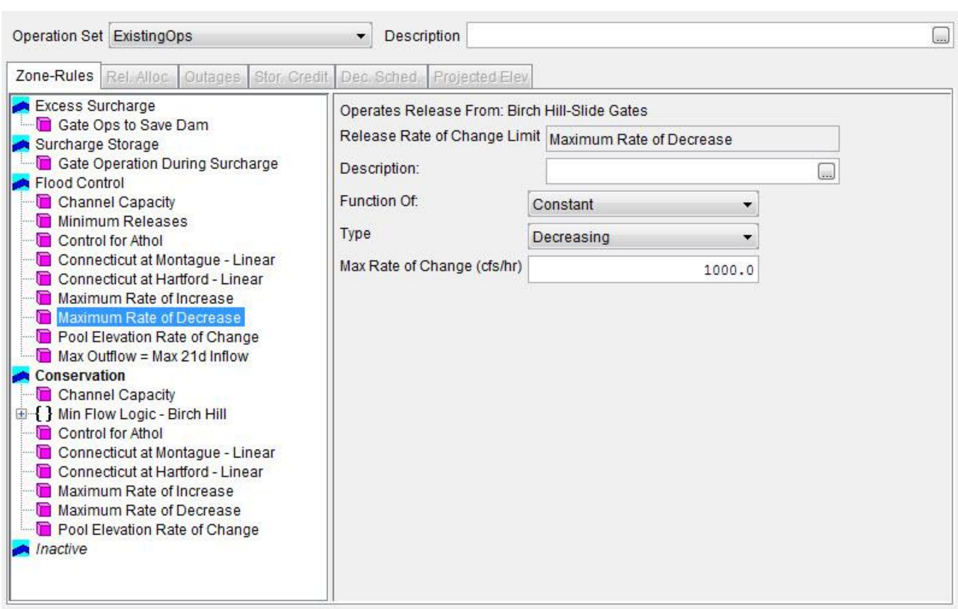


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maximum Rate of Decrease

10. Max Pool Elev ROC

Figure 16 shows the content of "Max Pool Elev ROC" rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

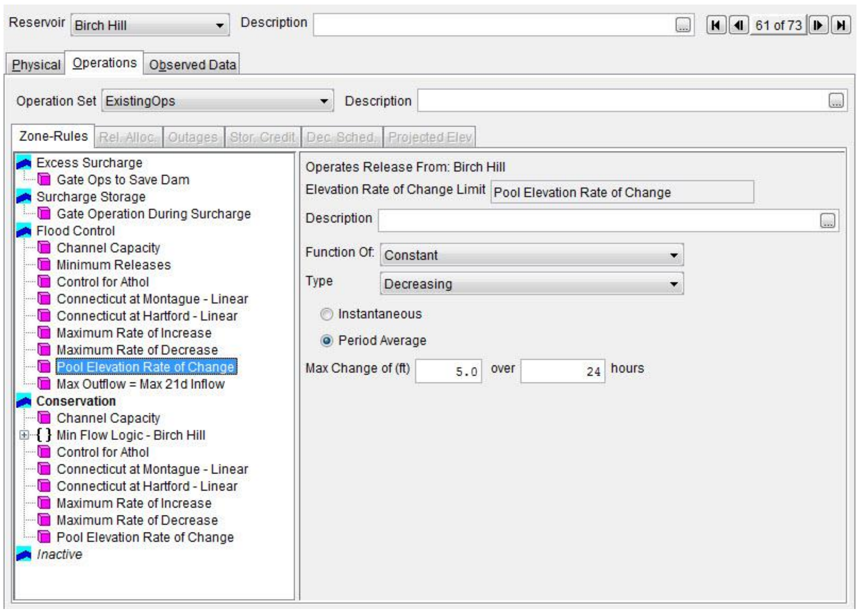


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet – Pool Elevation Rate of Change

11. Max Outfow equals 21 day max inflow

Figure 17 shows the content of "Max Outflow equals 21 day max inflow" rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

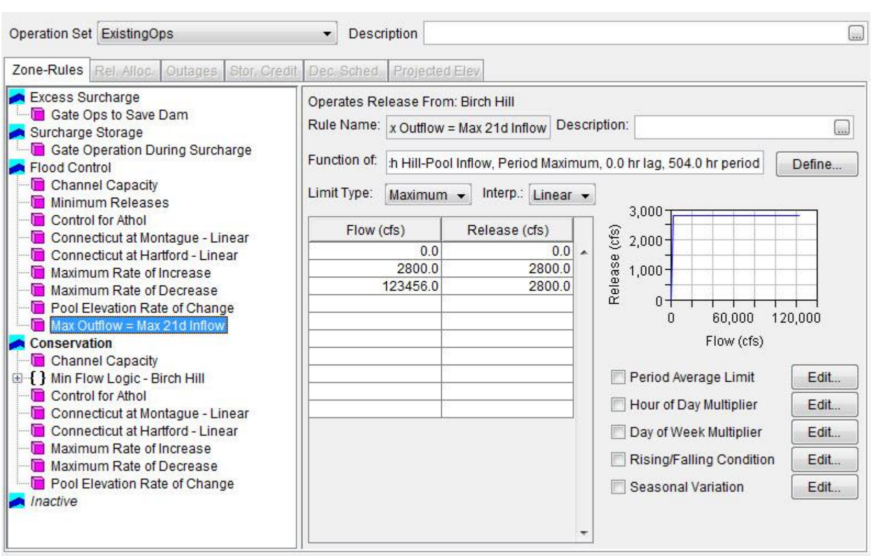


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals 21 day max inflow

12. Min flow Logic-Birch Hill

Figure 17 shows the content of “Min Flow Logic-Birch Hill” rule. This rule shows the minimum release from dam as a function of inflow for different months.

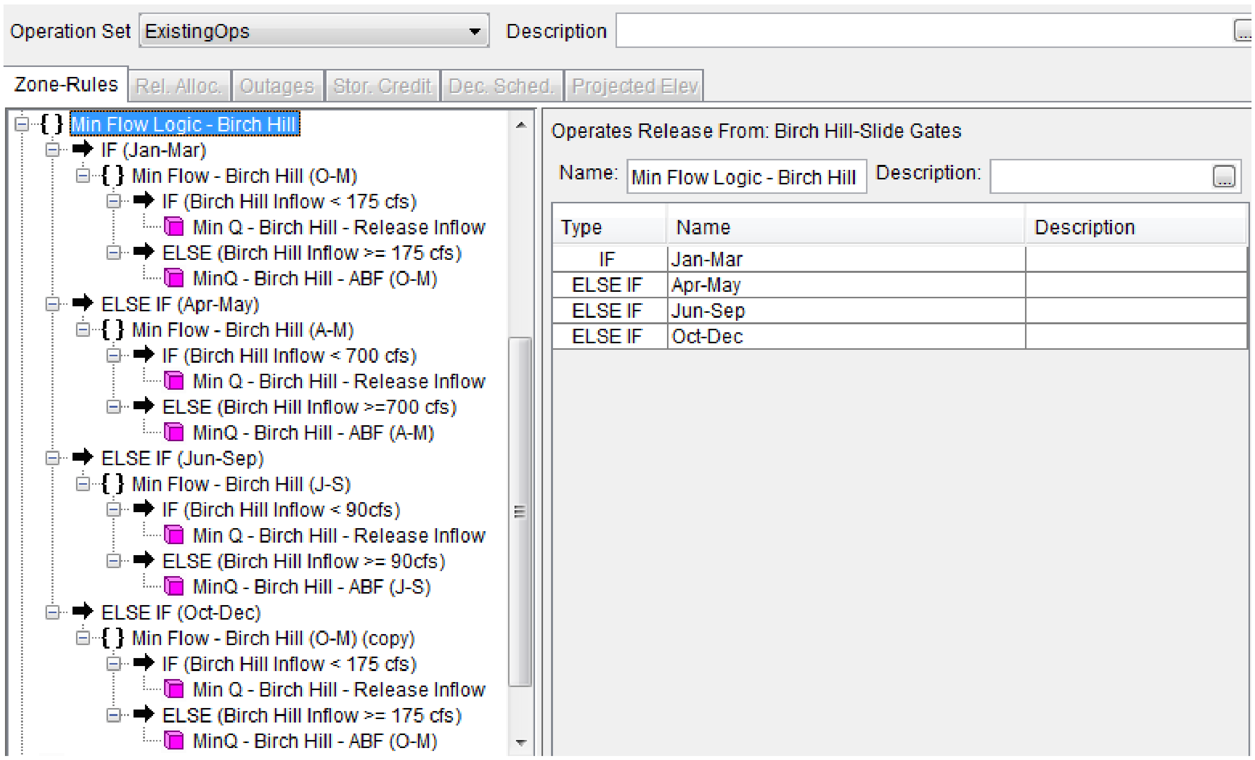


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet –Min Flow Logic-Birch Hill

Borden Brook

I. Overview

Borden Brook dam is located in Granville, MA and feeds into the Westfield River. It is owned by the City of Springfield and is used for drinking water supply and hydroelectric power generation. Construction of the dam was completed in 1909.

Figure 1 shows the location of Borden Brook Dam as it is represented in the HEC-ResSim model. Figure 2 shows an aerial view of the reservoir.

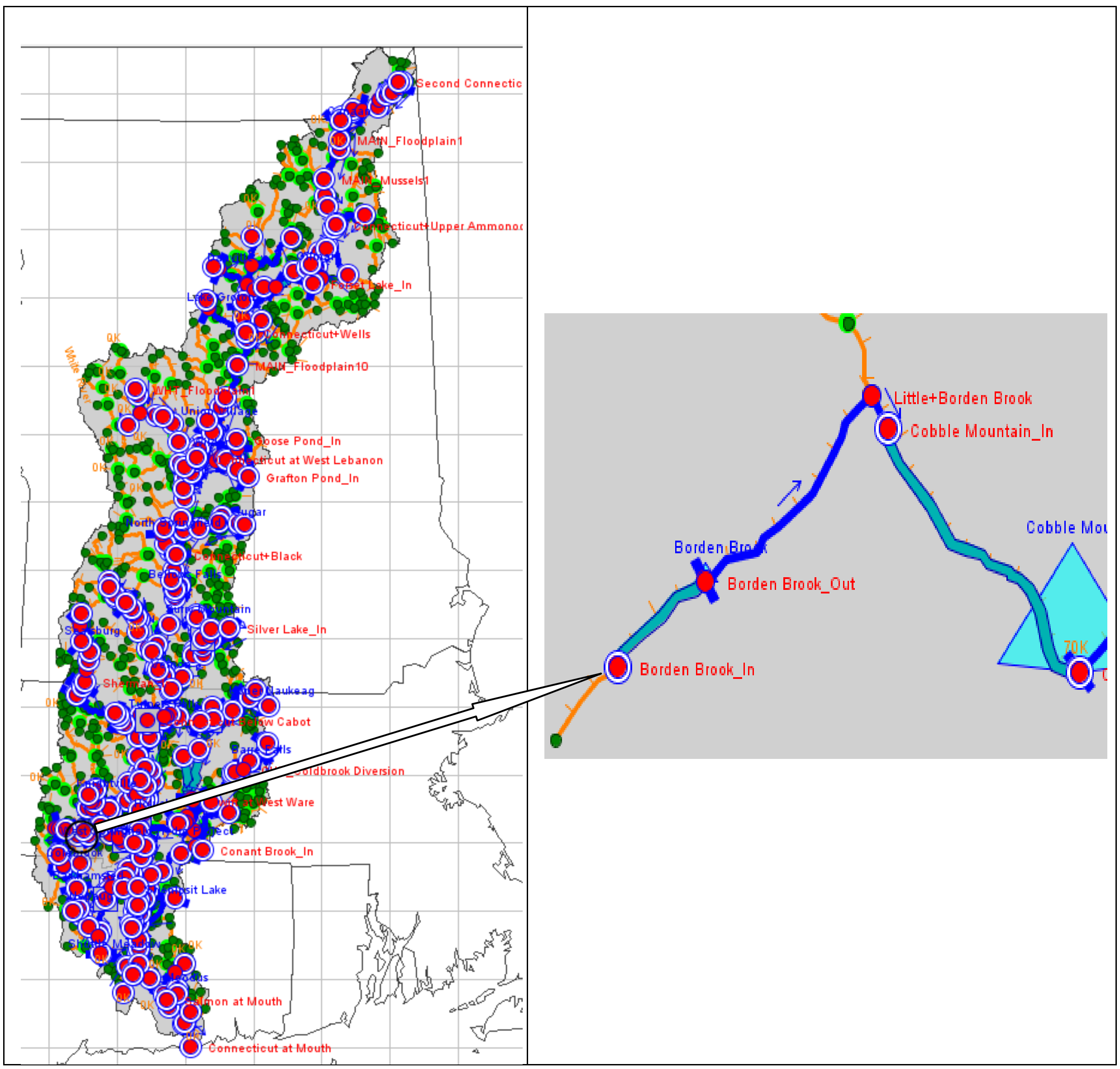


Figure 1: HEC-ResSim Map Display Showing Location of Borden Brook

Figure 2: Aerial photo of Borden Brook Reservoir

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[12]. The dam consists of four types of outlets: (1) uncontrolled spillway, (2) controlled Upper 24-inch outlet, (3) controlled Lower 24-inch outlet, and (4) controlled Low-Level 36-inch outlet as shown in Figure 4.

[12] Springfield Water and Sewer Commission. Water Supply System History and Statistics. 1999

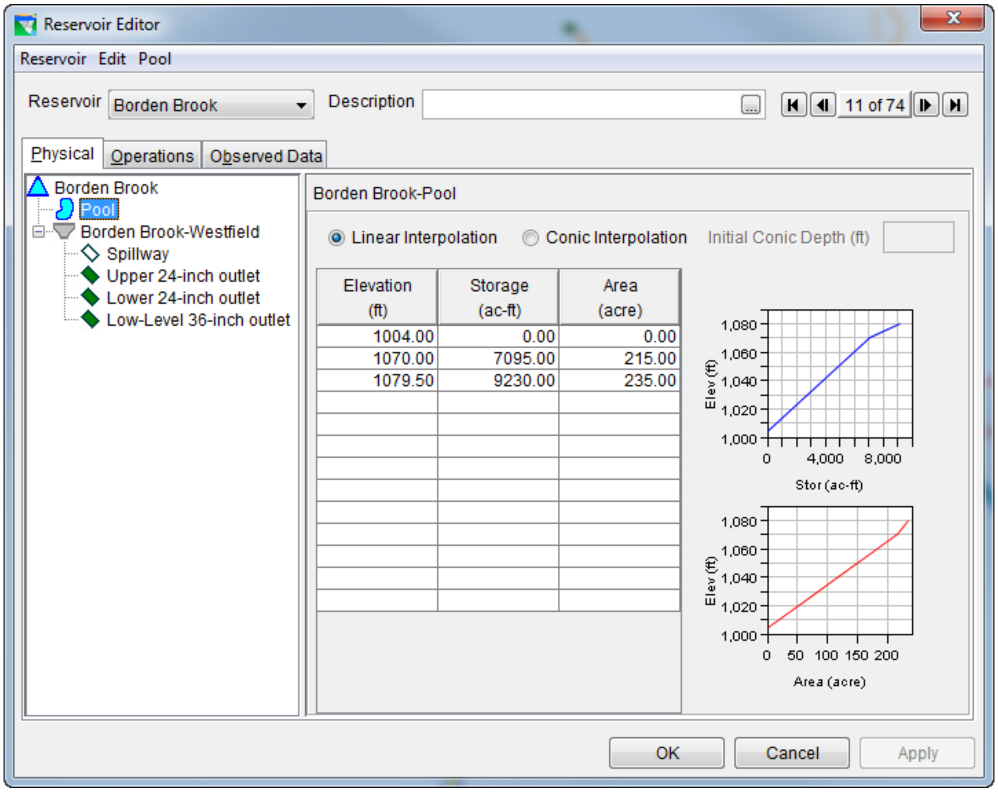


Figure 3: Reservoir Editor -- Physical Tab -- Pool

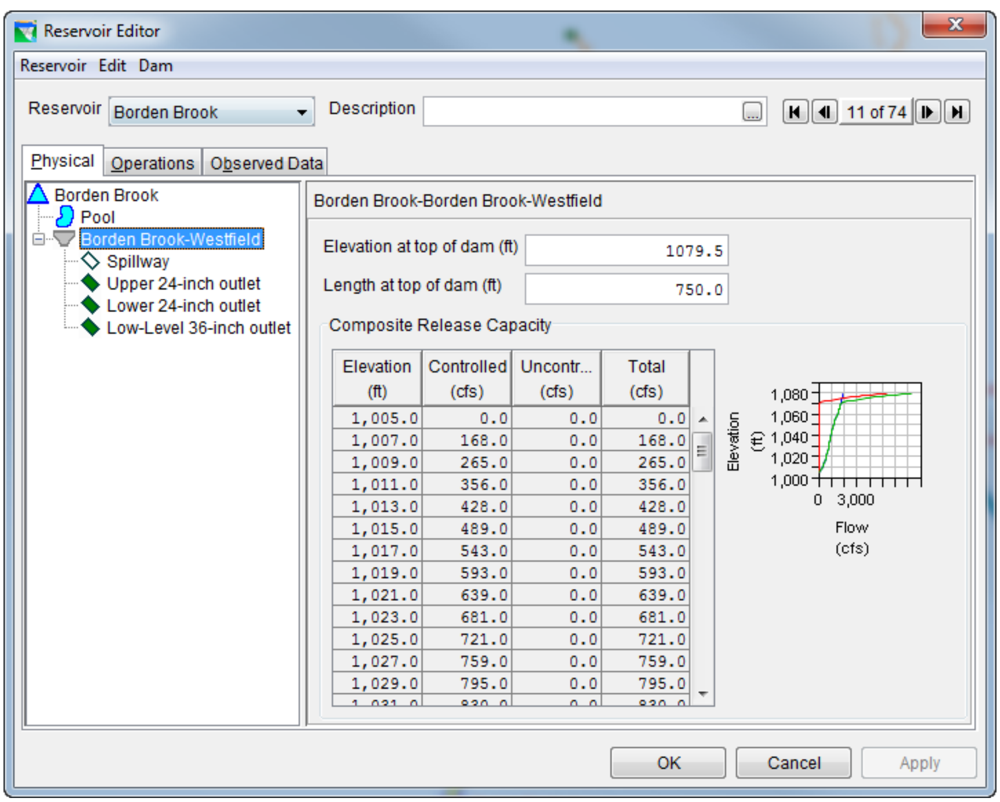


Figure 4: Reservoir Editor -- Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Borden Brook's "ExistingOps" operational zones, which consist of the zones Top of dam (1079.5 ft), Conservation (1070 ft), and Inactive (1004 ft)[1].

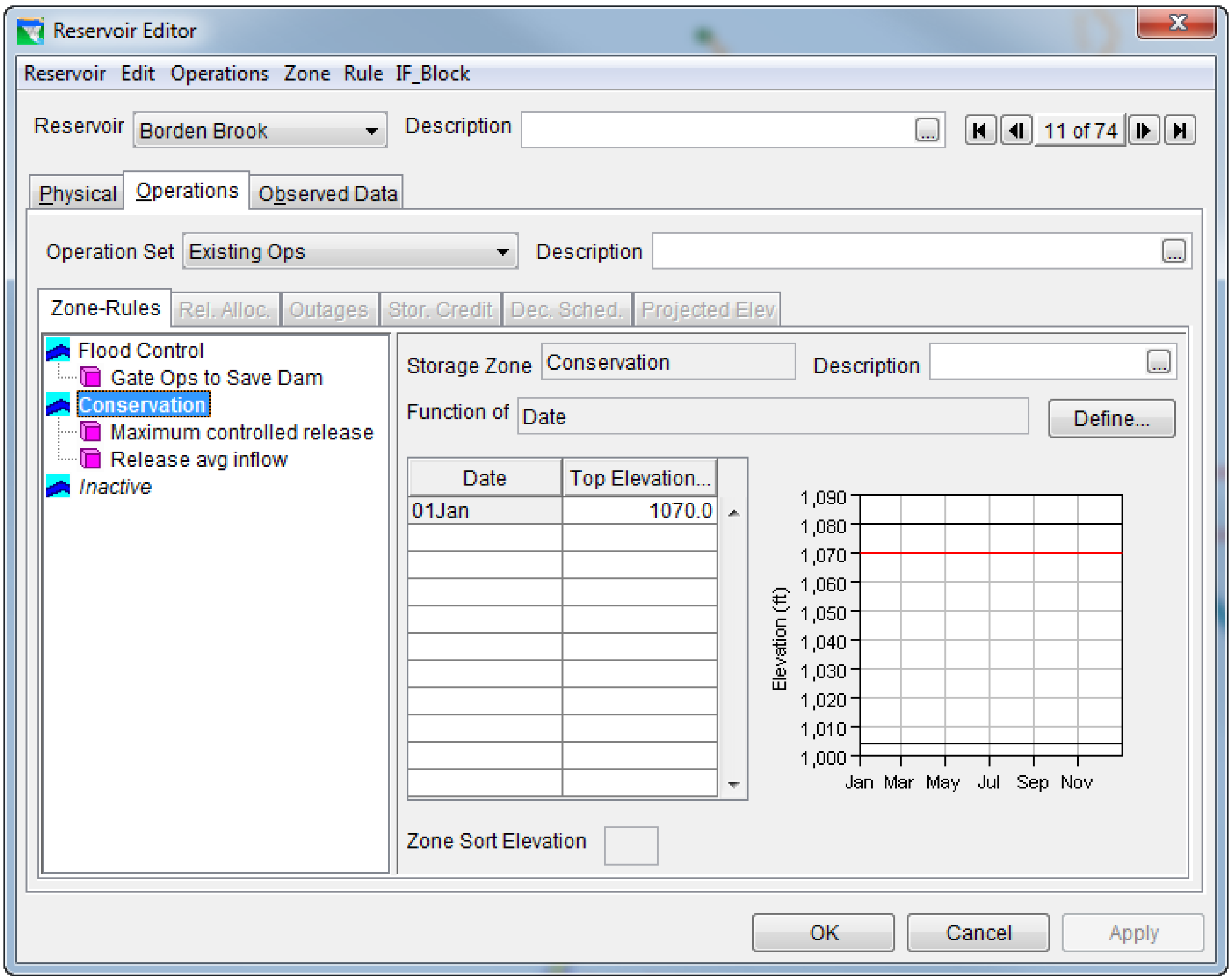


Figure 5: Reservoir Editor -- Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

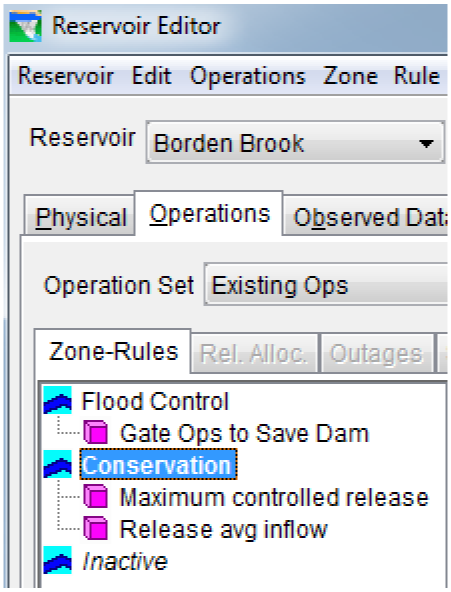


Figure 6: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Gate Ops to save Dam

Figure 7 shows the content of "Gate Ops to save Dam" rule. This rule increases the minimum release from Dam as a function of pool elevation.

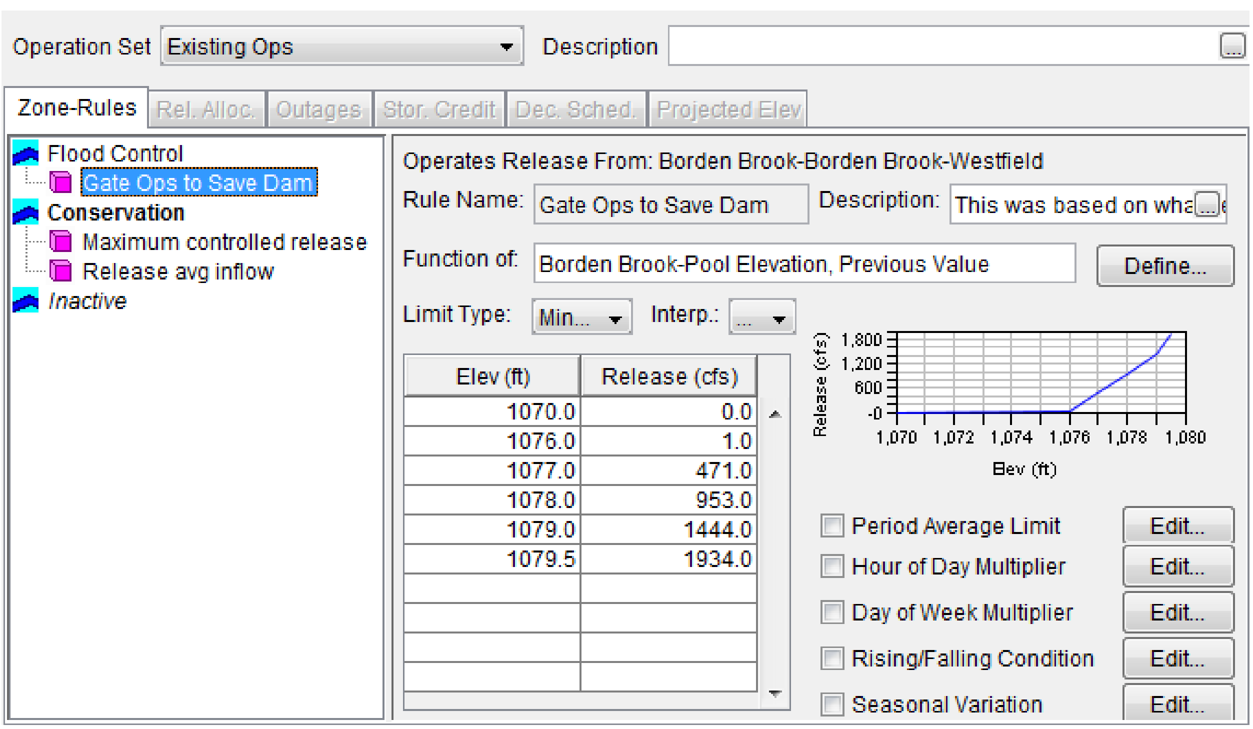


Figure 7: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Gates Ops to save Dam

2. *Maximum controlled release*

Figure 8 shows the content of "Maximum controlled release" rule. This rule represents the maximum release from reservoir as a function of date.

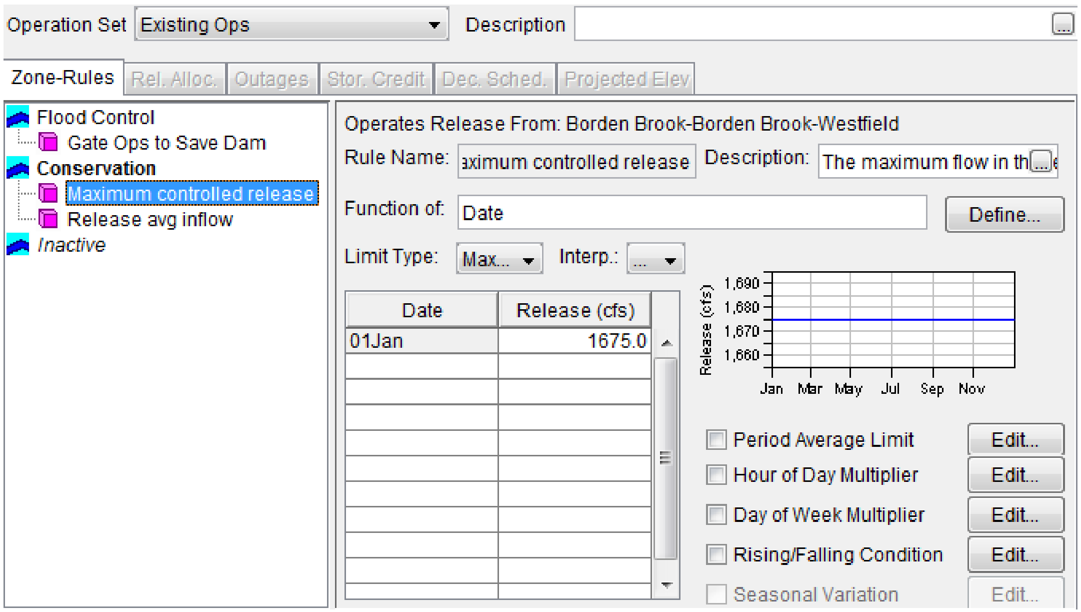


Figure 8: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Maximum controlled release

3. *Release avg Inflow*

Figure 9 shows the content of "Release avg Inflow" rule. This rule represents the maximum release from reservoir as a function of Inflow.

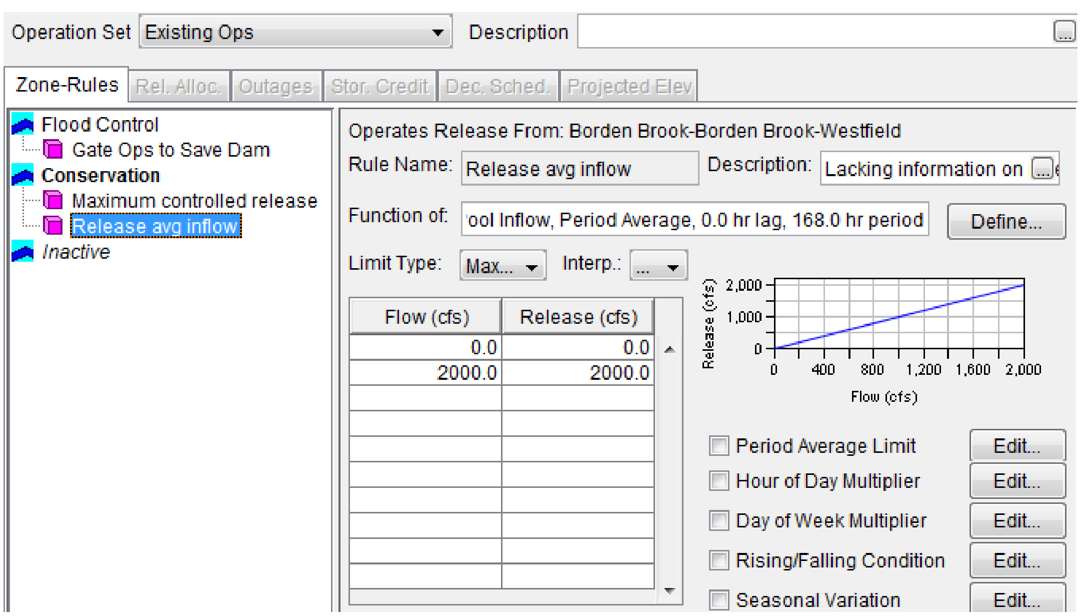


Figure 9: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Release avg inflow

Canaan

I. Overview

The Canaan Hydroelectric Project is an existing licensed minor hydroelectric project owned and operated by Public Service of New Hampshire (PSNH). It is located at river mile 370 on the Connecticut River, ten miles below Murphy Dam and 80 miles upstream of Gilman Dam. The project is located in the towns of Canaan, Vermont and Stewartstown, New Hampshire. It was originally constructed by the W.F. Allen Company in 1927; the dam, a concrete gravity structure, was reconstructed in 1943 to replace the timber dam that failed. The purpose of the dam is to impound water for hydroelectic power generation, however, it is currently operated on a strict run-of-river basis.

Figure 1 shows the location of Canon as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the project.

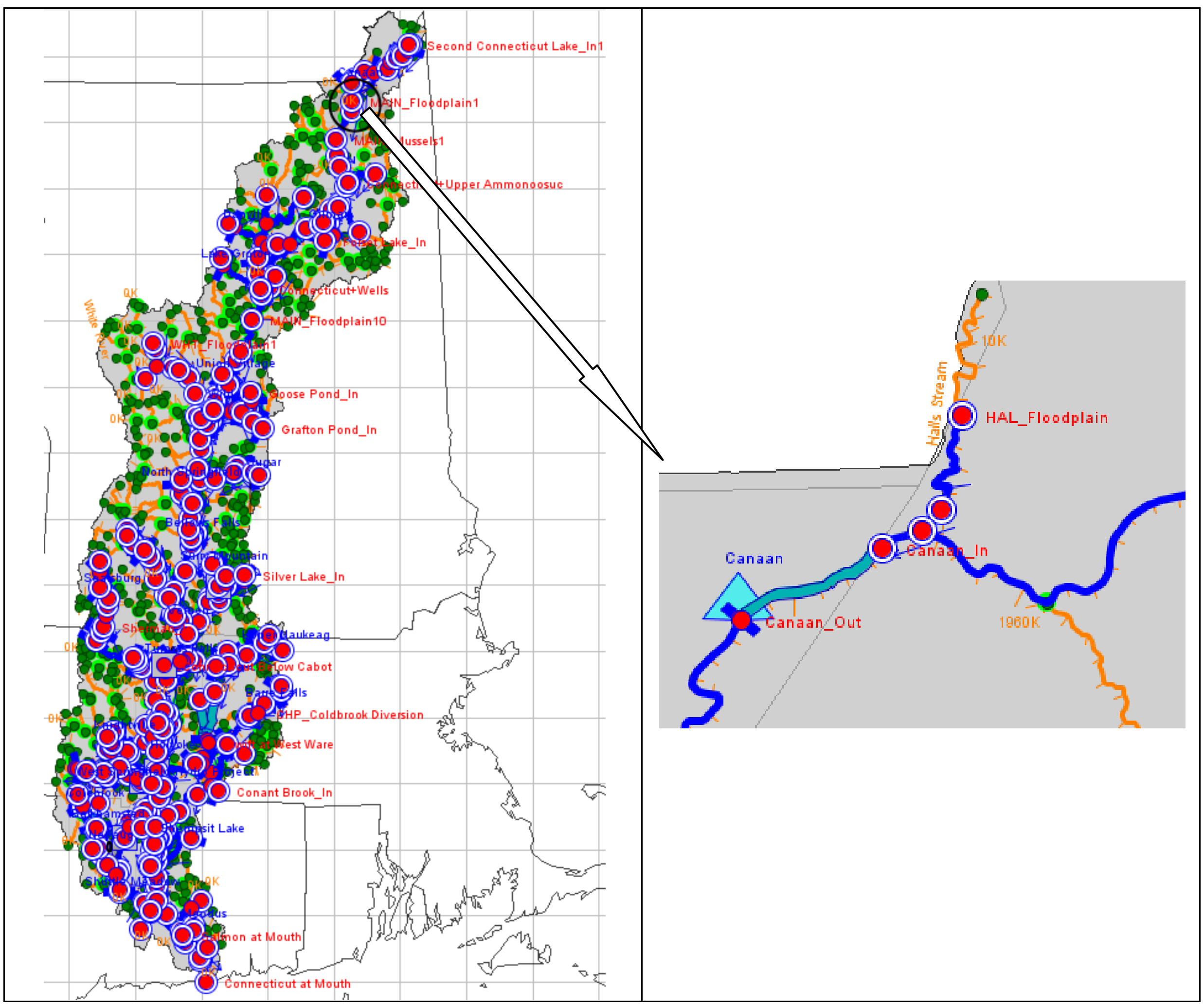


Figure 1: HEC-ResSim Map Display Showing Location of Caanan

Figure 2: Photo of Canaan Hydroelectric project

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[13]. The dam consists of seven types of outlets: (1) uncontrolled Bay#1, (2) uncontrolled Bay#5 (flashboards all in), (3) uncontrolled Bay#5 (flashboards partly cleared), (4) uncontrolled Bay#2, (5) uncontrolled Bay#3, (6) uncontrolled Bay#4 , and (7) controlled Tunnel discharge as shown in Figure 4[14]. The power plant has a maximum capacity of 550 cfs and a constant tailwater elevation of 1031.5 feet.

[13] NHDam Data Sheet. Canaan. 2003.
[14] National Dam Inspection Program. Phase I Inspection Report Canaan. 1980.

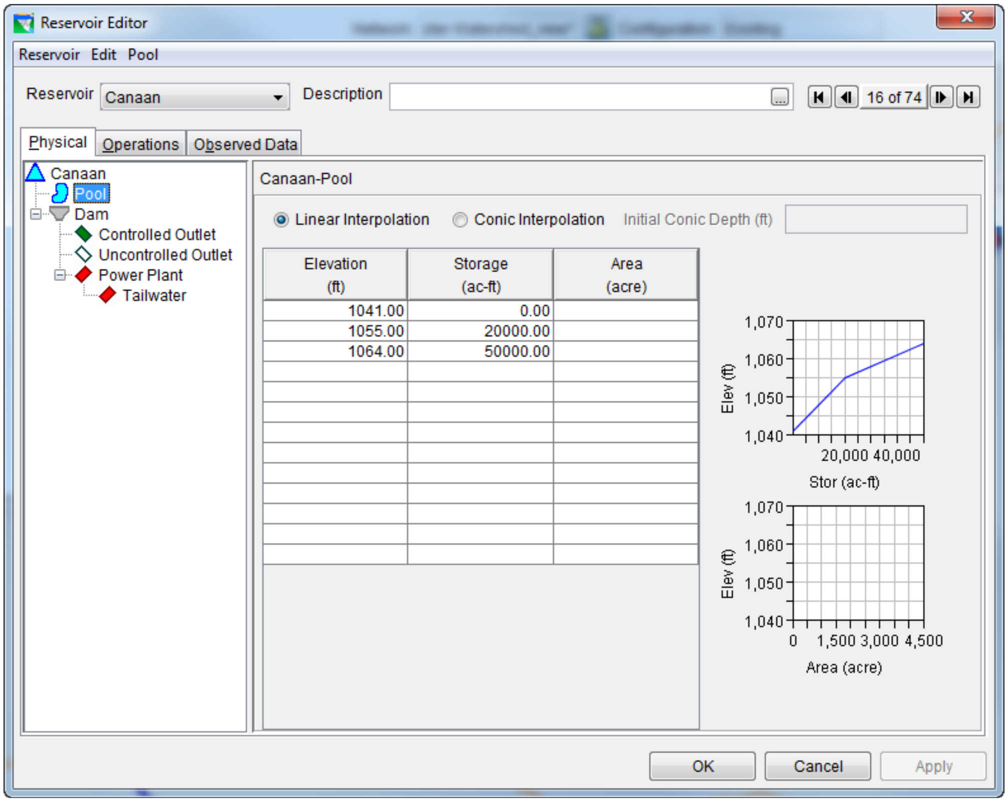


Figure 3: Reservoir Editor -- Physical Tab -- Pool

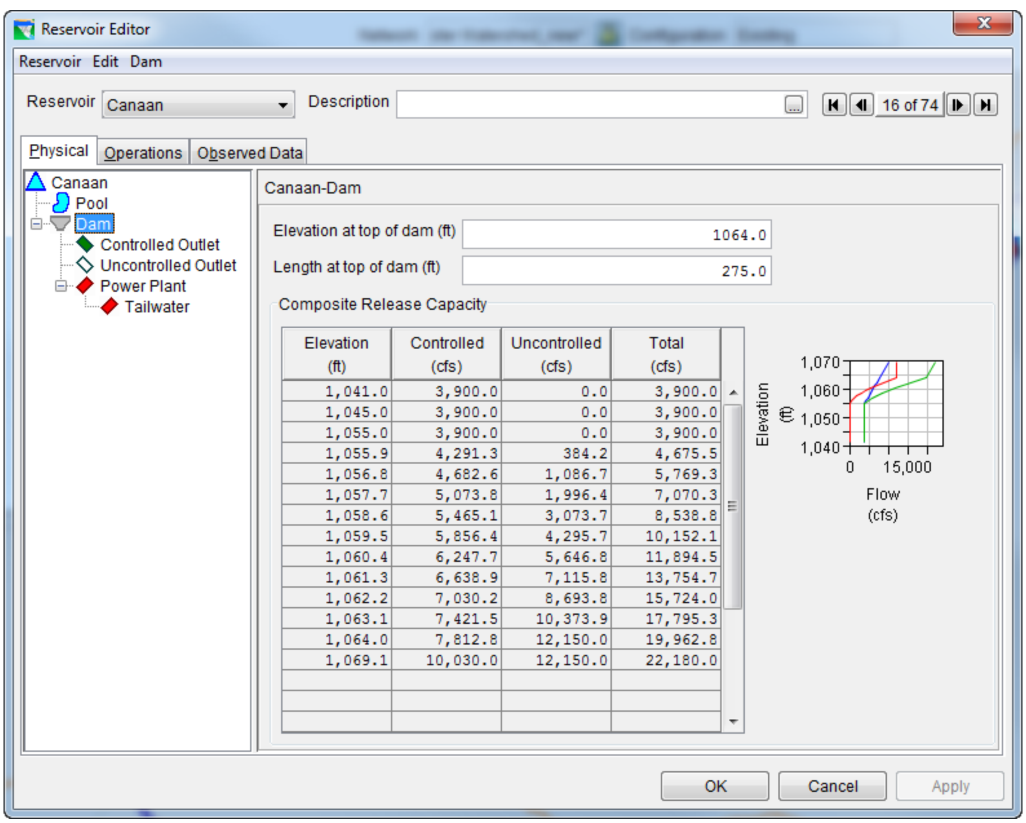


Figure 4: Reservoir Editor -- Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Canon Dam's "Existing Ops" operational zones, which consist of the zones Top of dam (1064 ft), Below Top of dam (1063 ft), Conservation (1055 ft), and Inactive (1042 ft)[1].

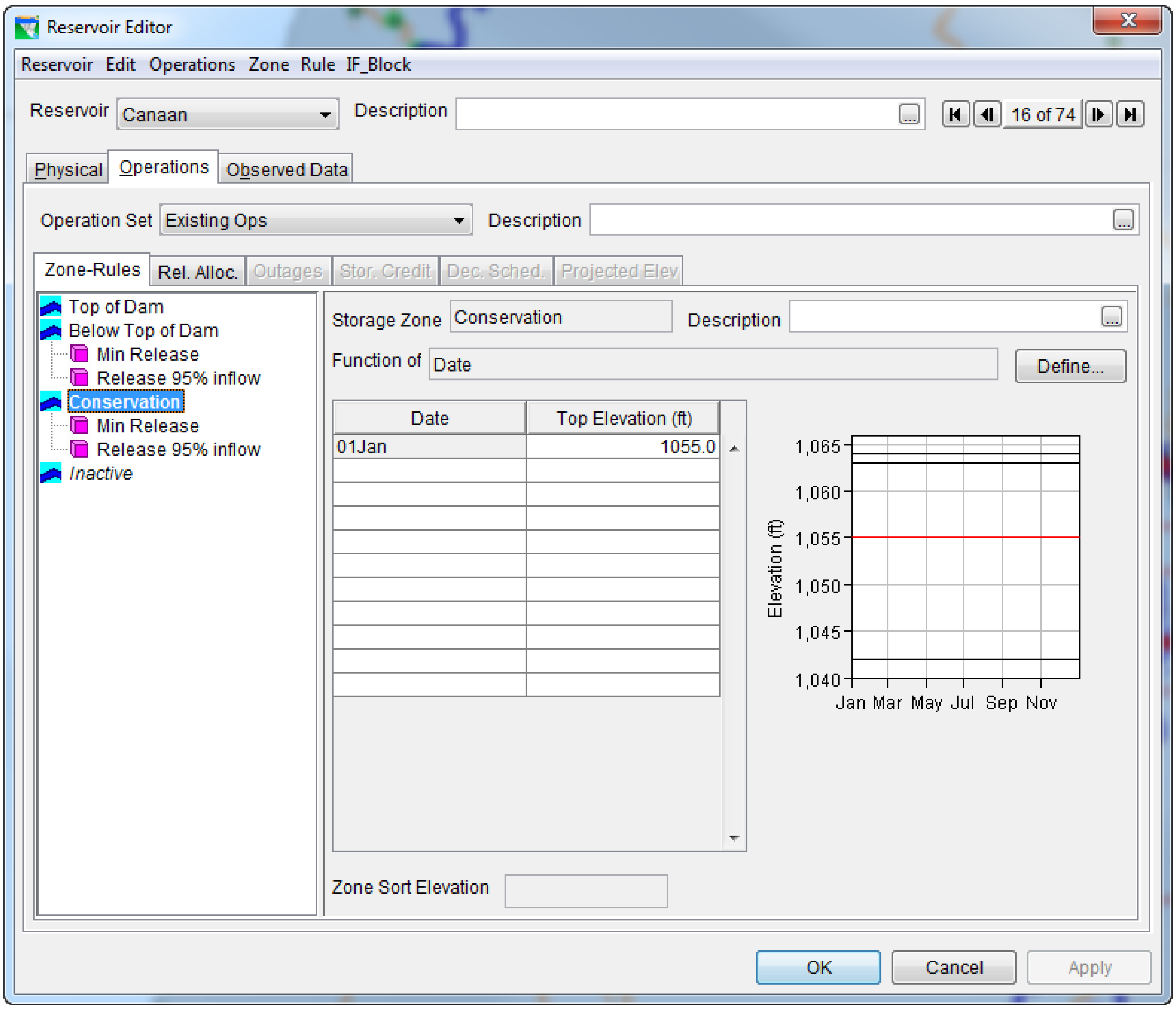


Figure 5: Reservoir Editor -- Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[15].

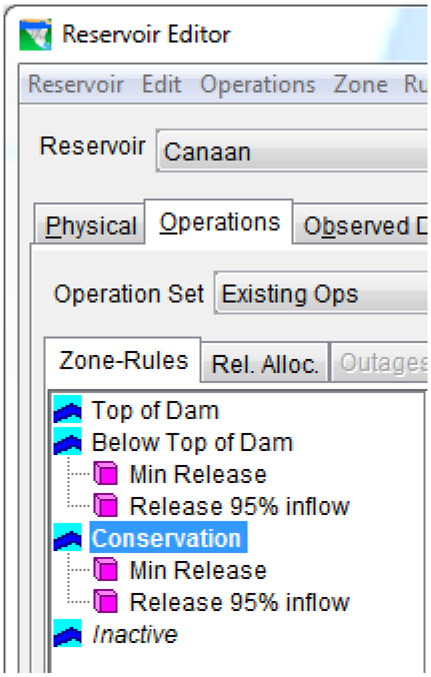


Figure 6: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Zones and Rules

[15] Public Service of New Hampshire. Canaan Hydroelectric Project: Flow Management and Impoundment & Flow Monitoring Plan. 2010.

C. Rule Descriptions

1. *Min Release*

Figure 7 shows the content of “Min Release” rule. This rule represents the constant minimum release from the dam.

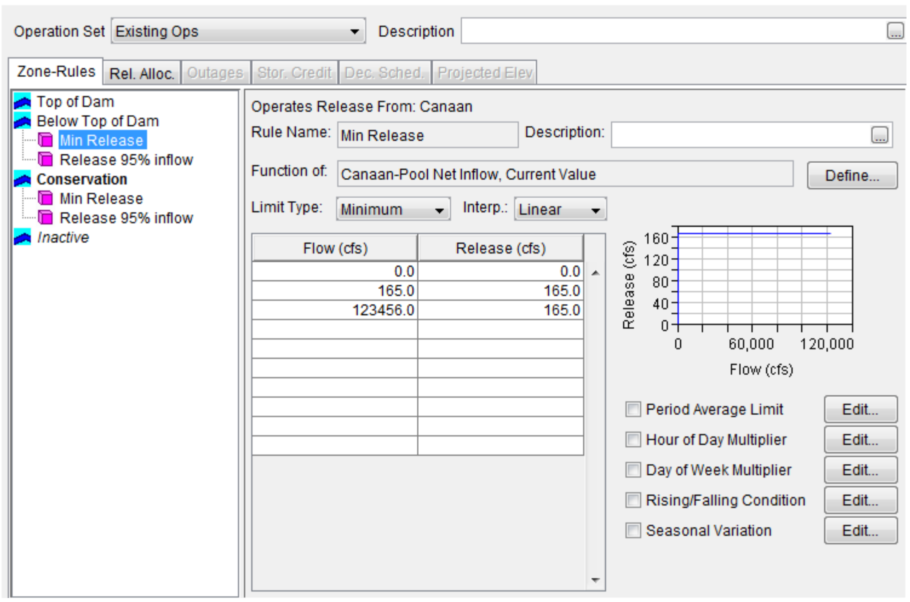


Figure 7: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Min Release

2. *Release 95% Inflow*

Figure 8 shows the content of “Release 95% Inflow” rule. This rule passes 95% of Inflow through power plant as per the run-of-river modeling strategy.

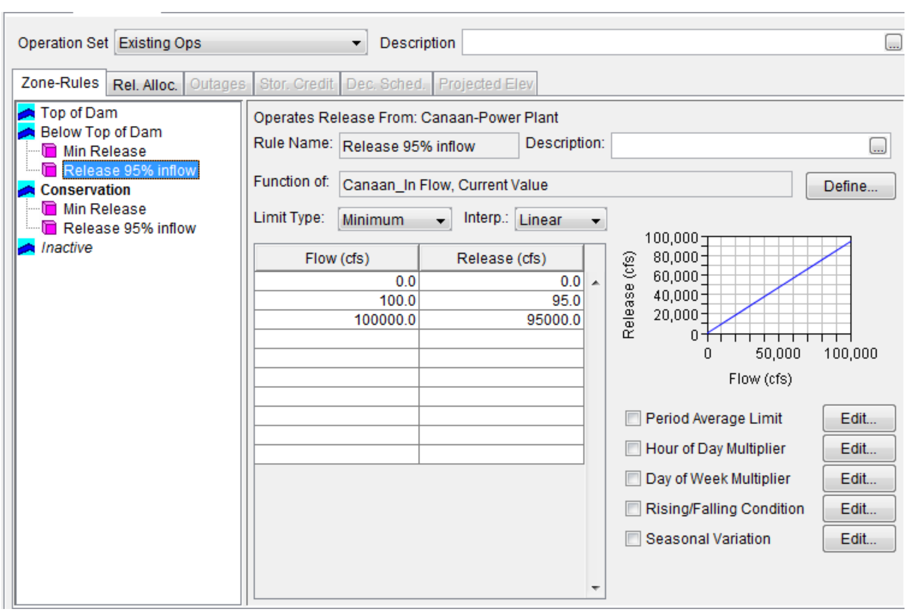


Figure 8: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Release 95% Infl

Cobble Mountain

I. Overview

Cobble Mountain dam is located in Granville, MA and feeds into the Westfield River. It is owned by the City of Springfield and is used for drinking water supply for the city.

Figure 1 shows the location of Cobble Mountain Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Cobble Mountain rerservoir.

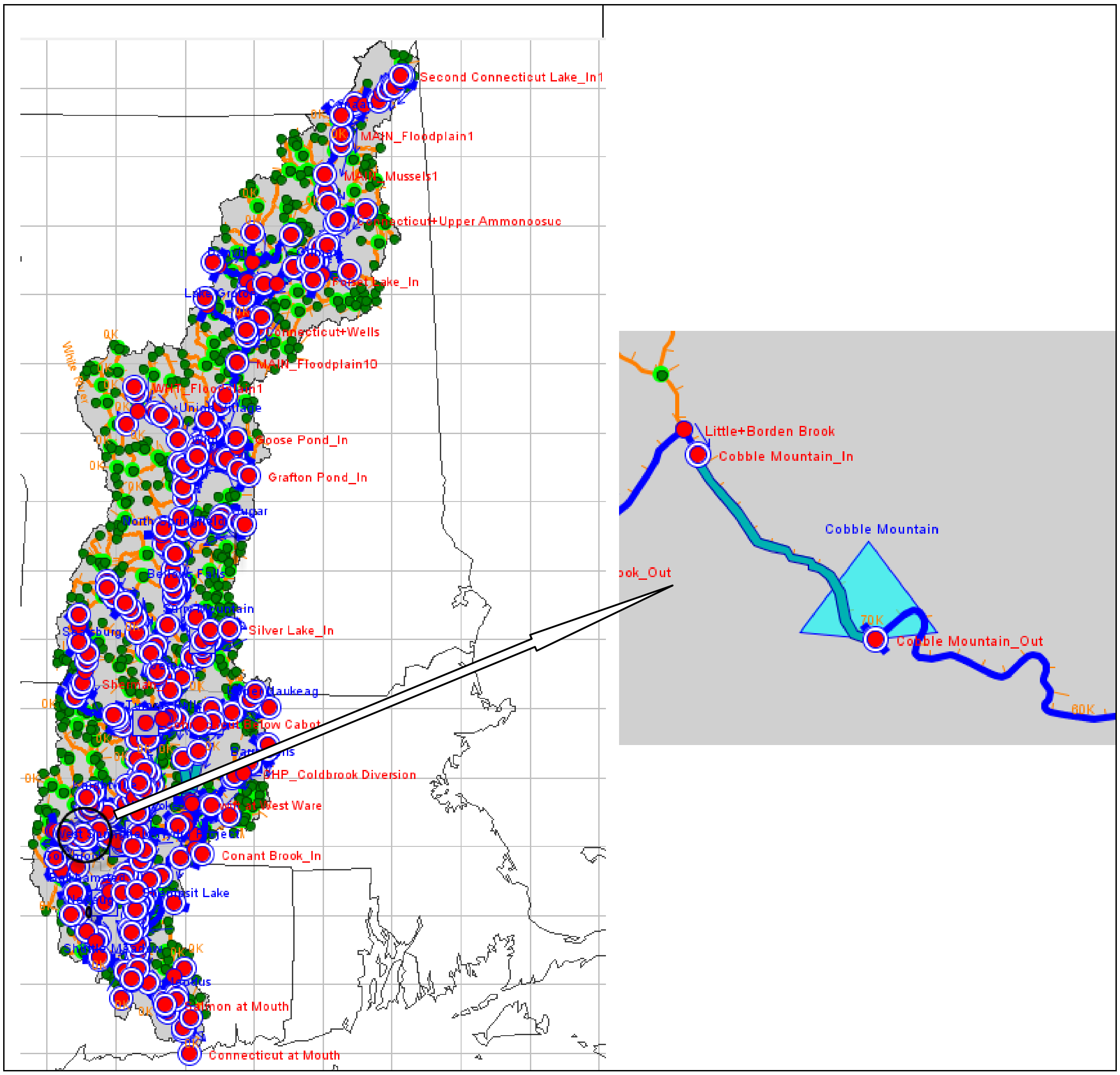


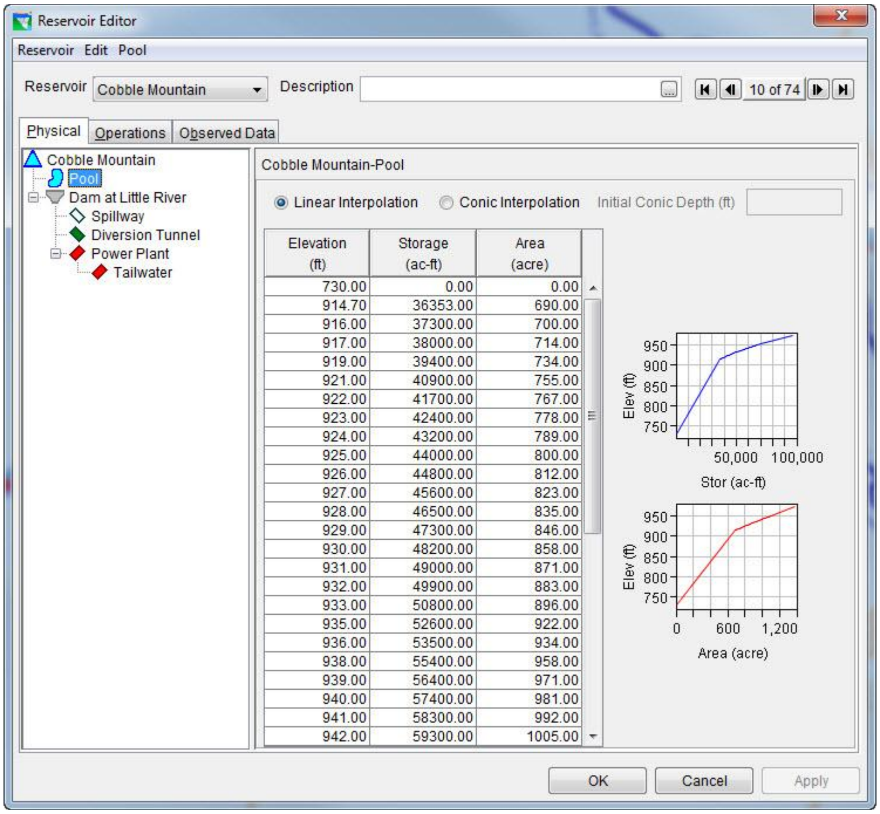
Figure 1: HEC-ResSim Map Display Showing Location of Cobble Mountain dam

Figure 2: Photo of Cobble Mountain reservoir

II. Physical Characteristics

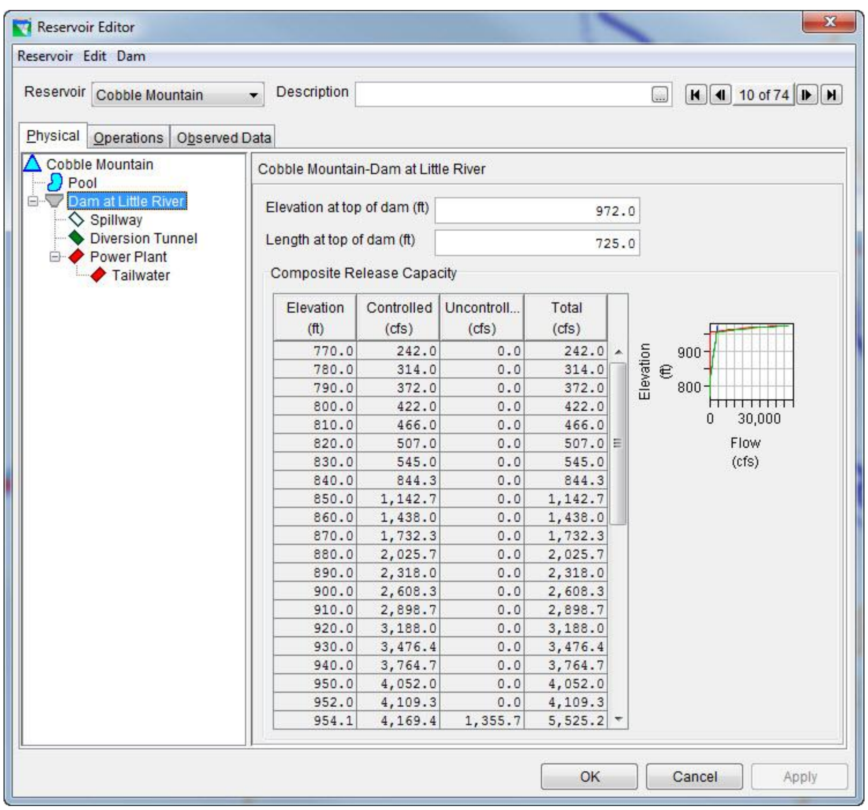
The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[16]. The dam consists of two types of outlets: (1) controlled slide gates, and (2) uncontrolled outlet, as shown in Figure 4.

[16] Springfield Water and Sewer Commission. Water Supply System History and Statistics. 1999



Elevation (ft)	Storage (ac-ft)	Area (acre)
730.00	0.00	0.00
914.70	36353.00	690.00
916.00	37300.00	700.00
917.00	38000.00	714.00
919.00	39400.00	734.00
921.00	40900.00	755.00
922.00	41700.00	767.00
923.00	42400.00	778.00
924.00	43200.00	789.00
925.00	44000.00	800.00
926.00	44800.00	812.00
927.00	45600.00	823.00
928.00	46500.00	835.00
929.00	47300.00	846.00
930.00	48200.00	858.00
931.00	49000.00	871.00
932.00	49900.00	883.00
933.00	50800.00	896.00
935.00	52600.00	922.00
936.00	53500.00	934.00
938.00	55400.00	958.00
939.00	56400.00	971.00
940.00	57400.00	981.00
941.00	58300.00	992.00
942.00	59300.00	1005.00

Figure 3: Reservoir Editor: Physical Tab -- Pool



Elevation (ft)	Controlled (cfs)	Uncontroll... (cfs)	Total (cfs)
770.0	242.0	0.0	242.0
780.0	314.0	0.0	314.0
790.0	372.0	0.0	372.0
800.0	422.0	0.0	422.0
810.0	466.0	0.0	466.0
820.0	507.0	0.0	507.0
830.0	545.0	0.0	545.0
840.0	844.3	0.0	844.3
850.0	1,142.7	0.0	1,142.7
860.0	1,438.0	0.0	1,438.0
870.0	1,732.3	0.0	1,732.3
880.0	2,025.7	0.0	2,025.7
890.0	2,318.0	0.0	2,318.0
900.0	2,608.3	0.0	2,608.3
910.0	2,898.7	0.0	2,898.7
920.0	3,188.0	0.0	3,188.0
930.0	3,476.4	0.0	3,476.4
940.0	3,764.7	0.0	3,764.7
950.0	4,052.0	0.0	4,052.0
952.0	4,109.3	0.0	4,109.3
954.1	4,169.4	1,355.7	5,525.2

Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Cobble Mountain's "ExistingOps" operational zones, which consist of zones of Flood Control (972 ft), Conservation (940 ft), and Inactive zone (754 ft)[1].

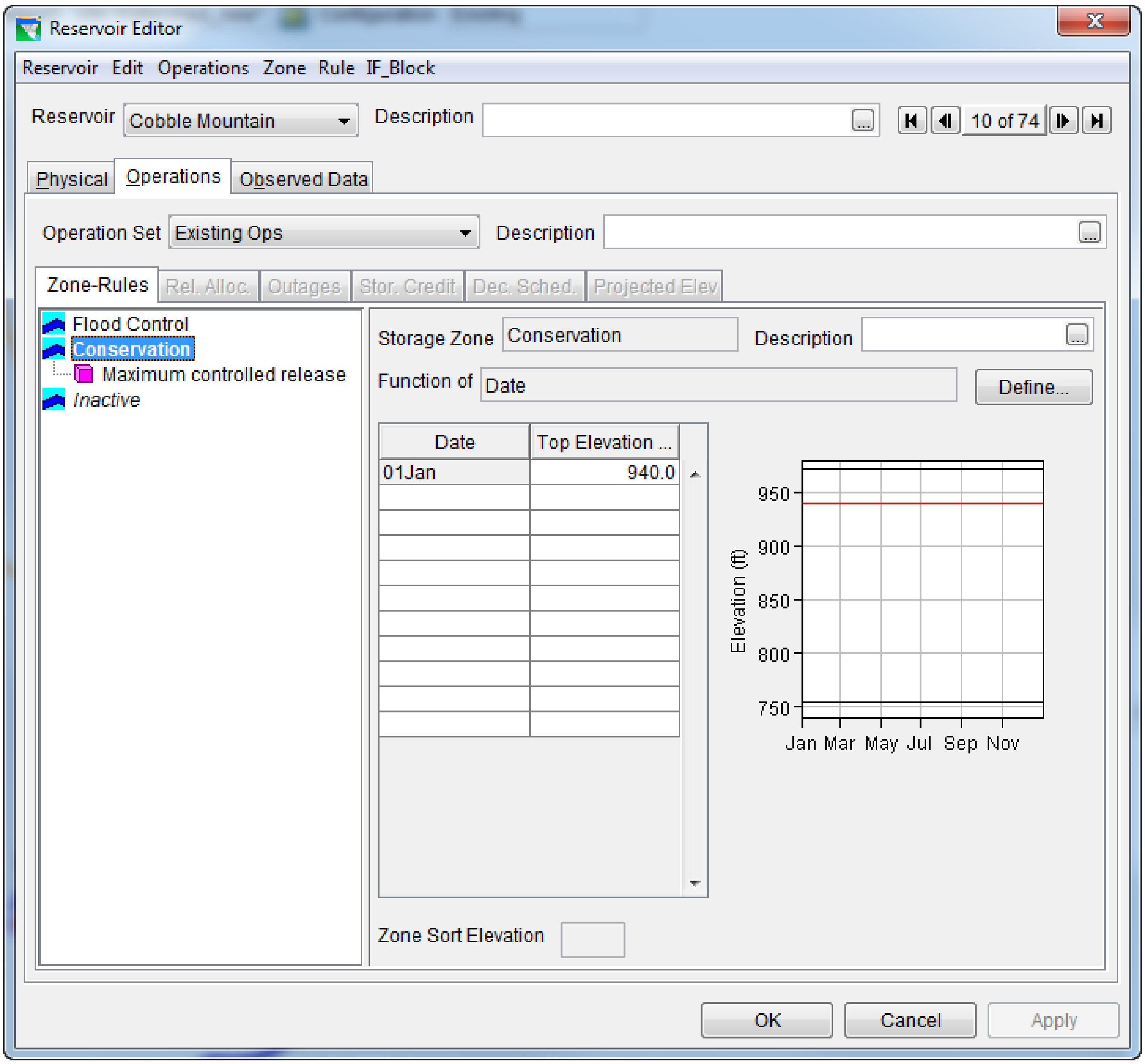


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. There is a water supply timeseries for Cobble Mountain that is described in the water supply section of the report.

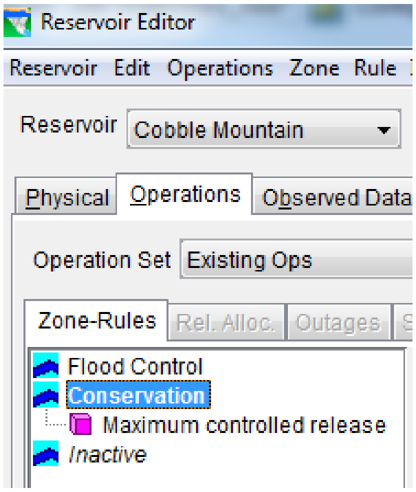


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. *Maximum controlled release*

Figure 7 shows the content of "Maximum controlled release" rule. This rule shows the maximum release of 1675 cfs from Cobble Mountain.

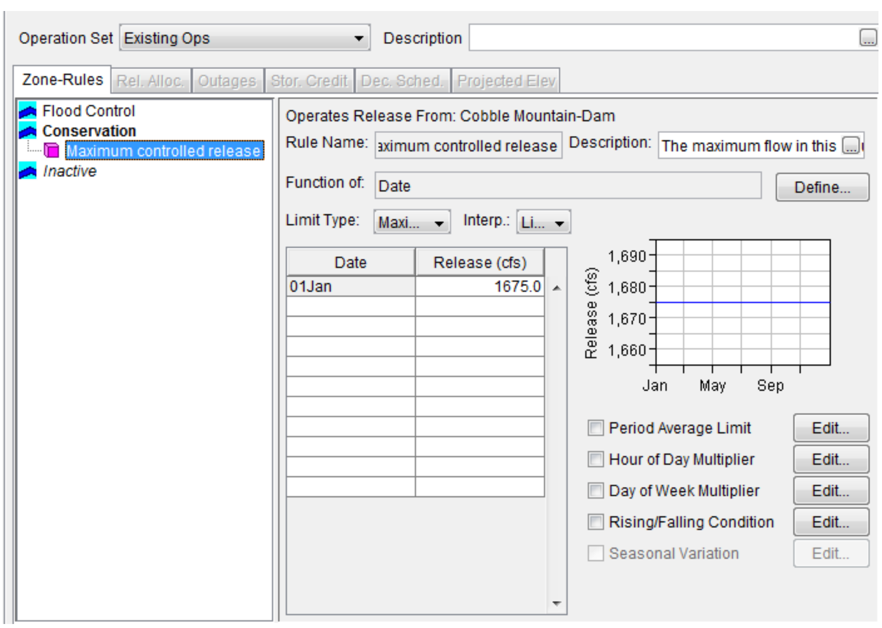


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maximum controlled relea

Colebrook

I. Overview

Completed in 1969, Colebrook River Dam is owned and operated by the Metropolitan District Commission (MDC), a non-profit municipal corporation chartered to supply drinking water and sewage treatment to Hartford and its surrounding municipalities. During flood conditions, the Corps is responsible for water releases. The primary function of the reservoir is for flood control. The water storage capacity of Colebrook is approximately 10 BG, while the total capacity of the dam is approximately 31.5 BG. Colebrook is FERC licensed to the MDC and authorized for 3,000 KW[17].

Figure 1 shows the location of Colebrook Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from Colebrook Dam.

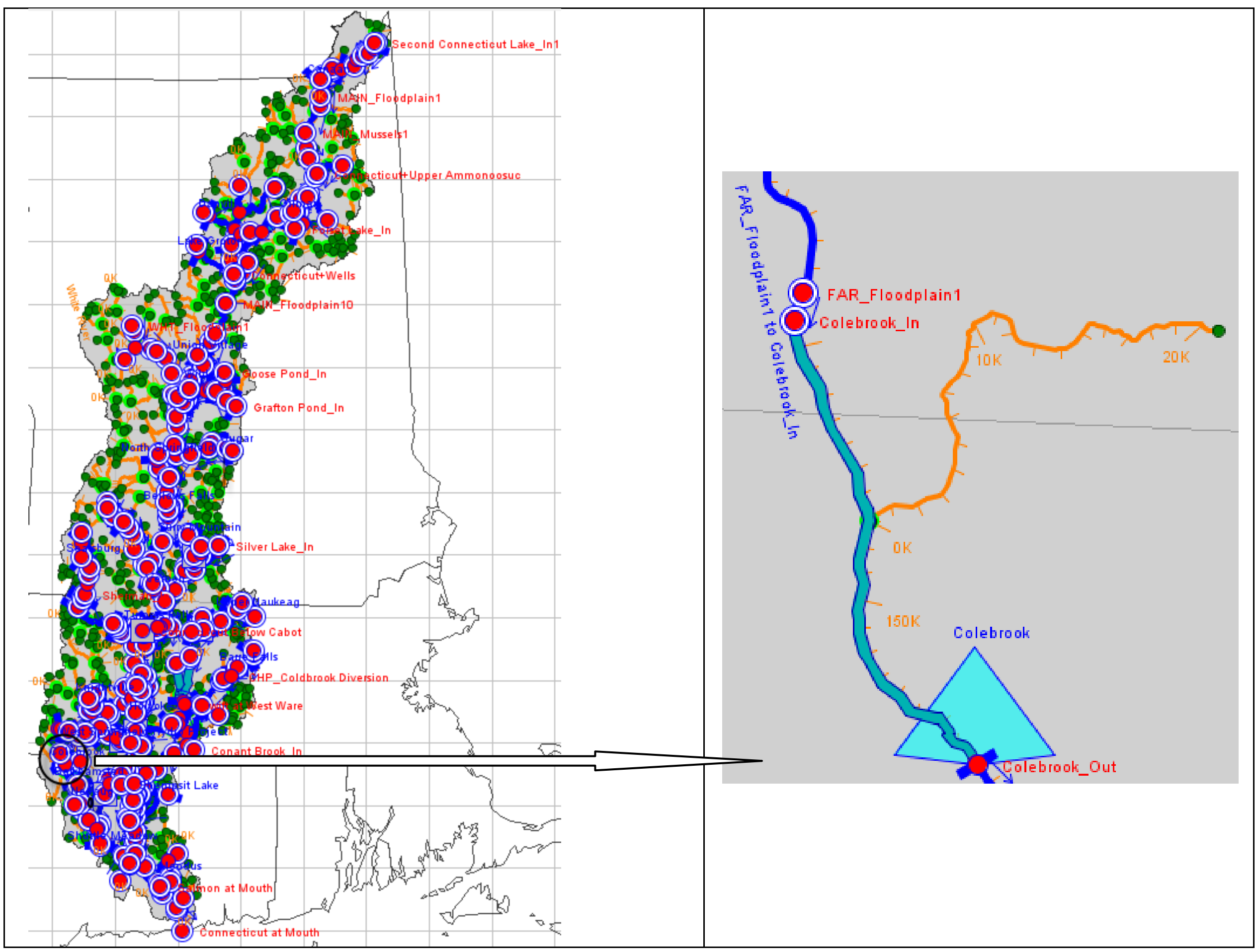


Figure 1 HEC-ResSim Map Display Showing Location of Colebrook dam

[17] Adamec, K. *Farmington Model Documentation*. University of Massachusetts, 2009.

Figure 2: Photo of Colebrook dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of three types of outlets: (1) controlled outlet, and (2) uncontrolled outlet, and (3) power plant as shown in Figure 4. All physical and operations data and are from Adamec 2009 and the US Army Corps New England District, either from a previously created ResSim model or the Reservoir Regulation Team website[18].

[18] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

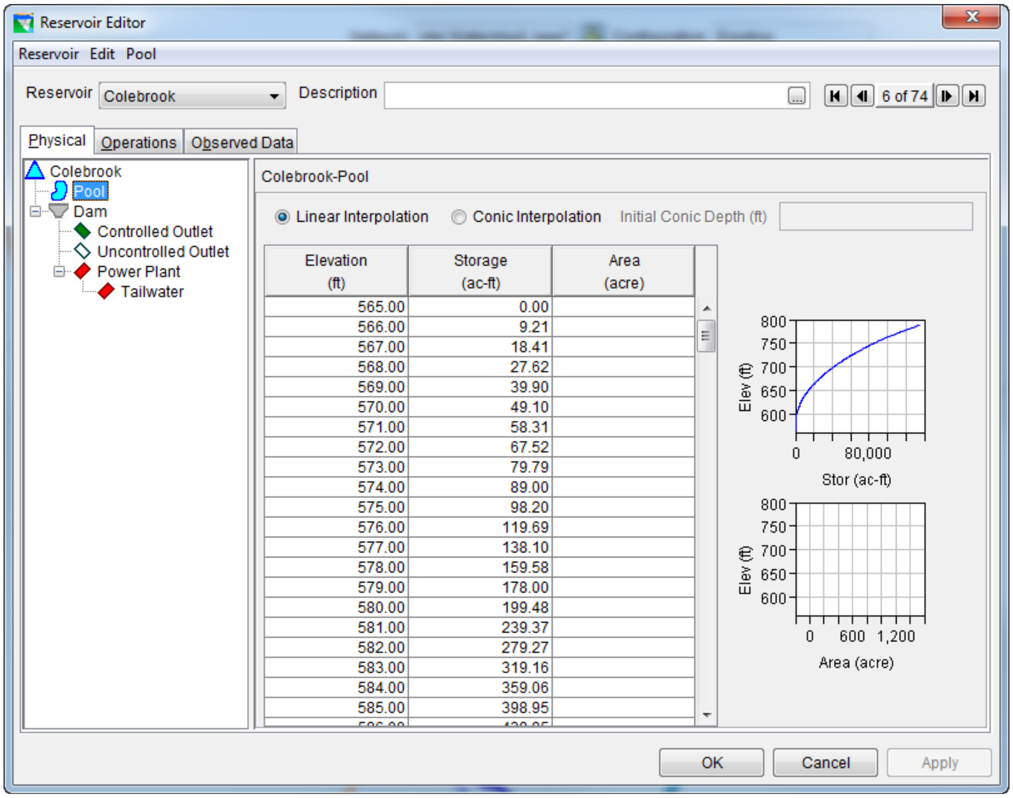


Figure 3: Reservoir Editor: Physical Tab -- Pool

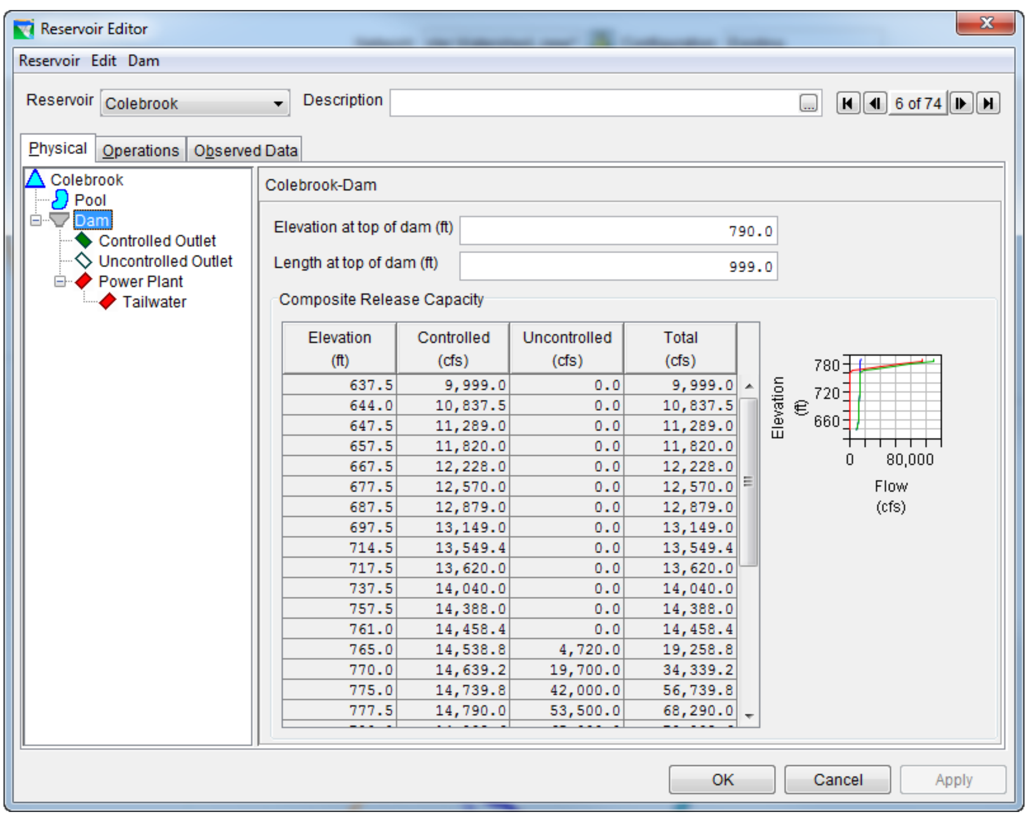


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Colebrook's "Existing Ops" operational zones, which consist of zones of Top of dam (790 ft), Flood Control (761 ft), Spring & Fall Fisheries Storage (708-714.5 ft), MDC Water Supply (701.2 ft), Operational Inactive (644 ft), and Inactive zone (640 ft).

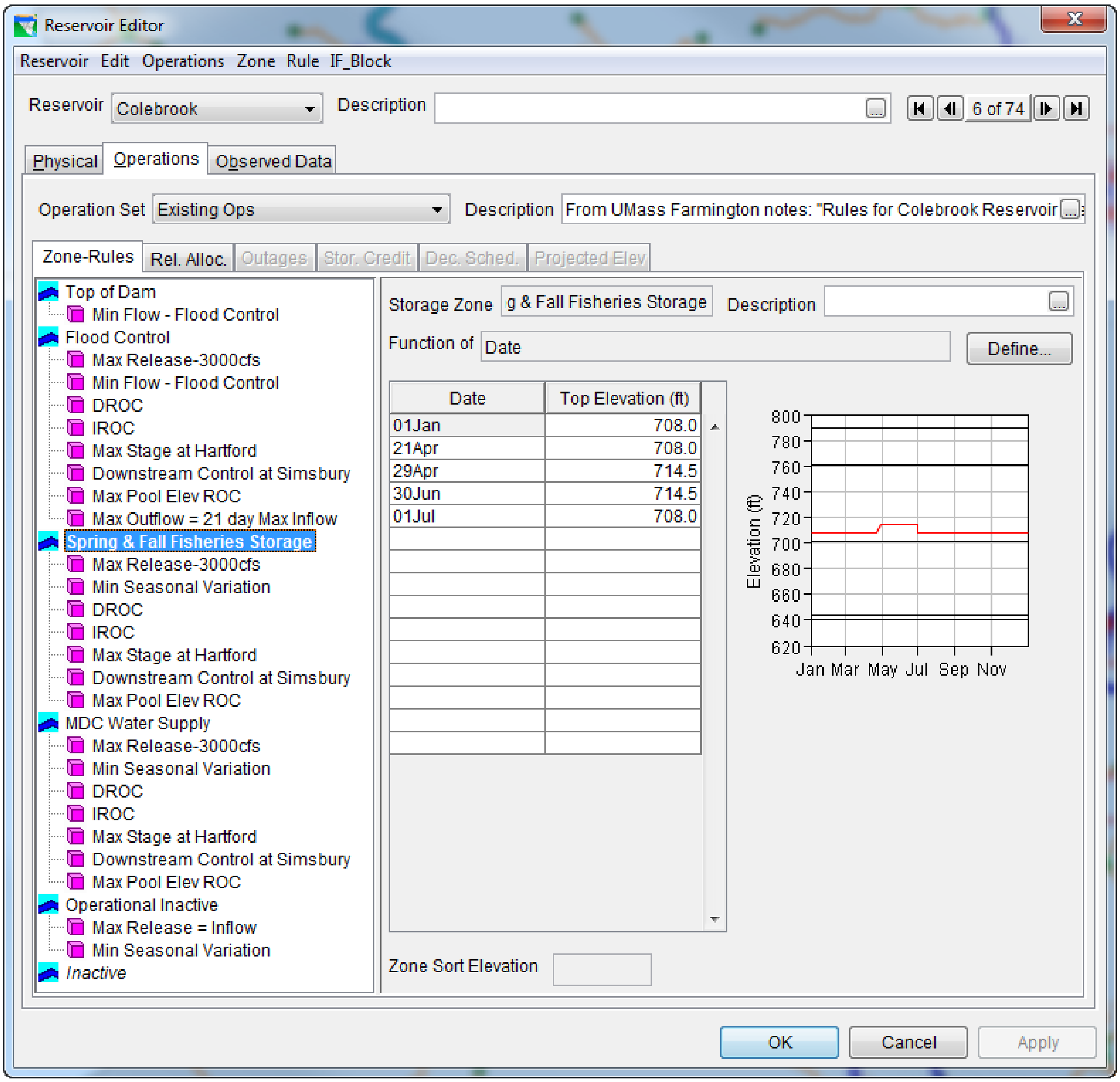


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[19]. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

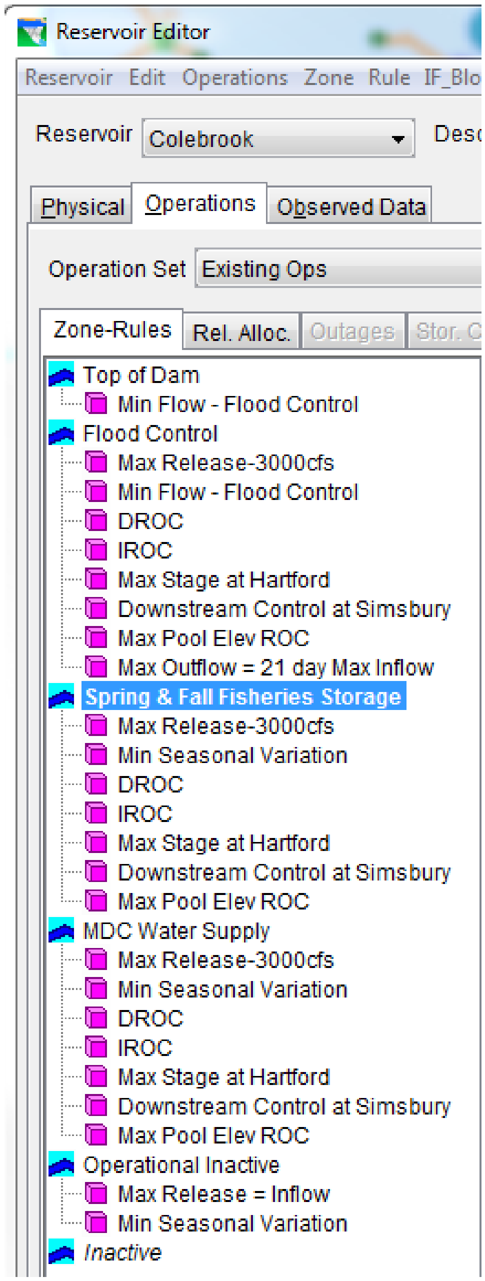


Figure 6: Reservoir Editor: Operations Tab – Existing OpSet – Zones and Rules

[19] Adamec 2009

Figure 7 shows a sequential release allocation approach specified for available outlets along Colebrook Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The controlled gate gets the remainder of the release.

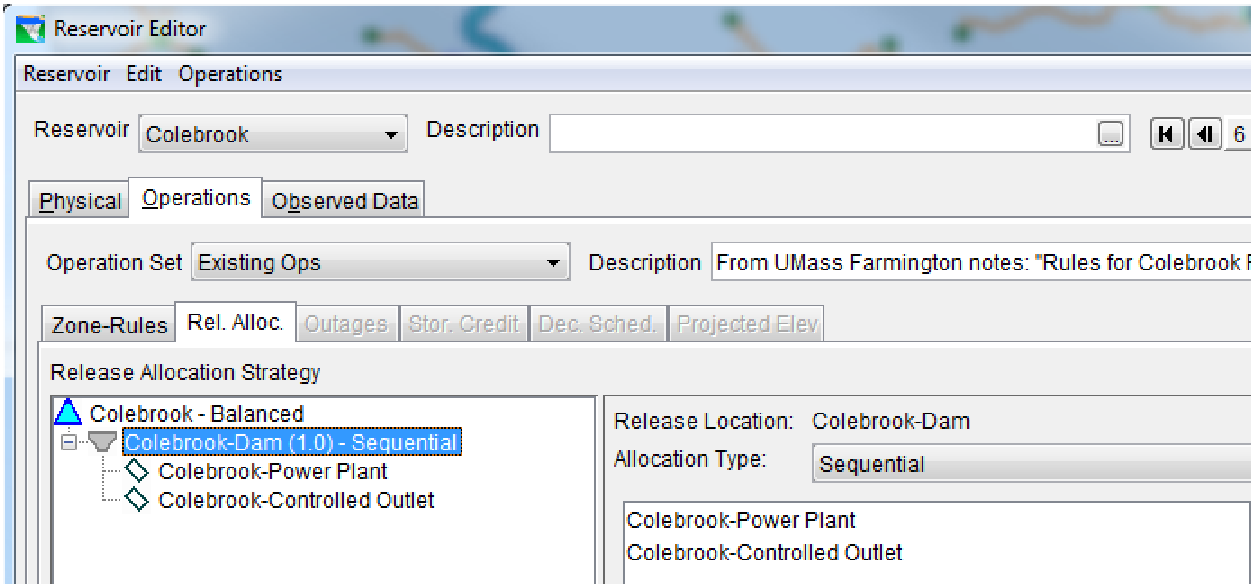


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

C. Rule Descriptions

1. Min Flow-Flood Control

Figure 8: shows the content of "Min Flow-Flood Control" rule. This rule presents the minimum required release of 50 cfs from the dam during flood control operations.

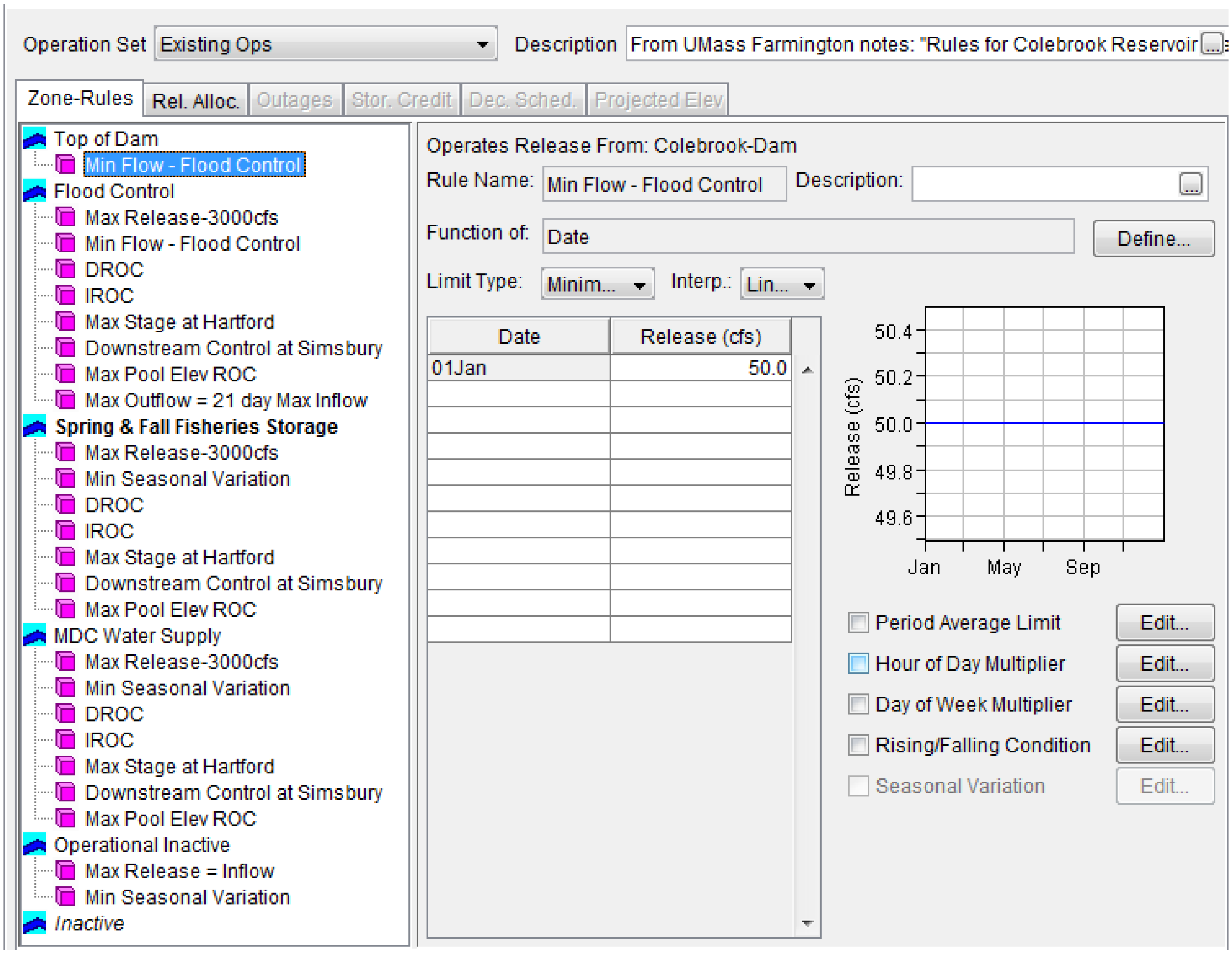


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow-Flood Control

2. *Max Release-3000cfs*

Figure 9 shows the content of "Max release-3000cfs" rule. This rule presents the maximum release of 3000 cfs from dam.

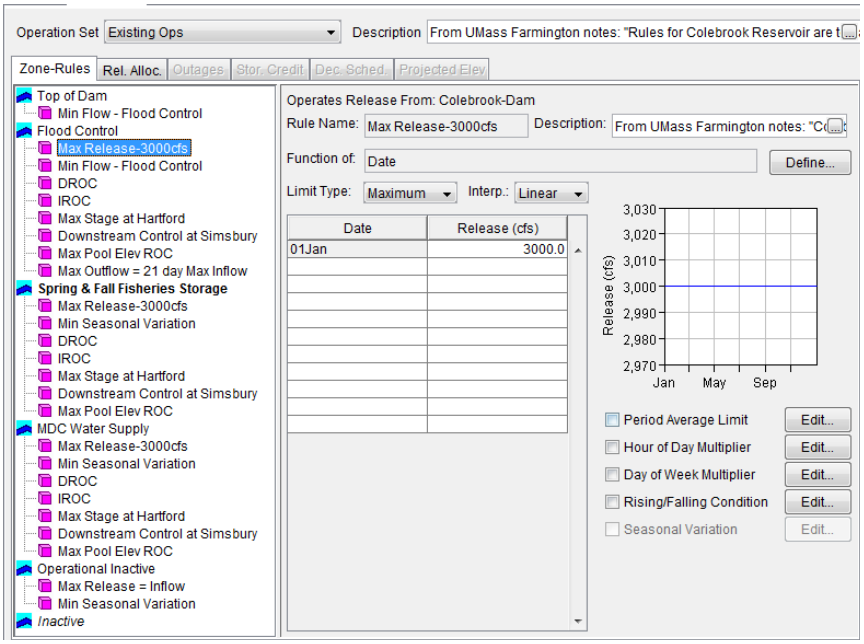


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max release-3000cfs

3. *DROC*

Figure 10 shows the content of "DROC" rule. This rule shows the decreasing maximum allowable release rate of change rule from Colebrook dam.

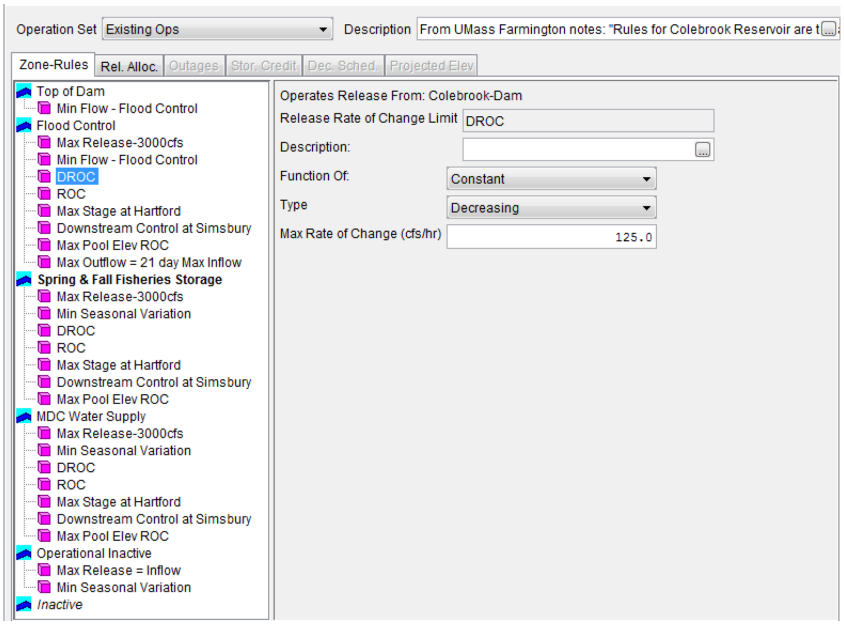


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Decreasing-ROC

4. *Increasing-ROC*

Figure 11 shows the content of "Increasing-ROC" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Colebrook dam.

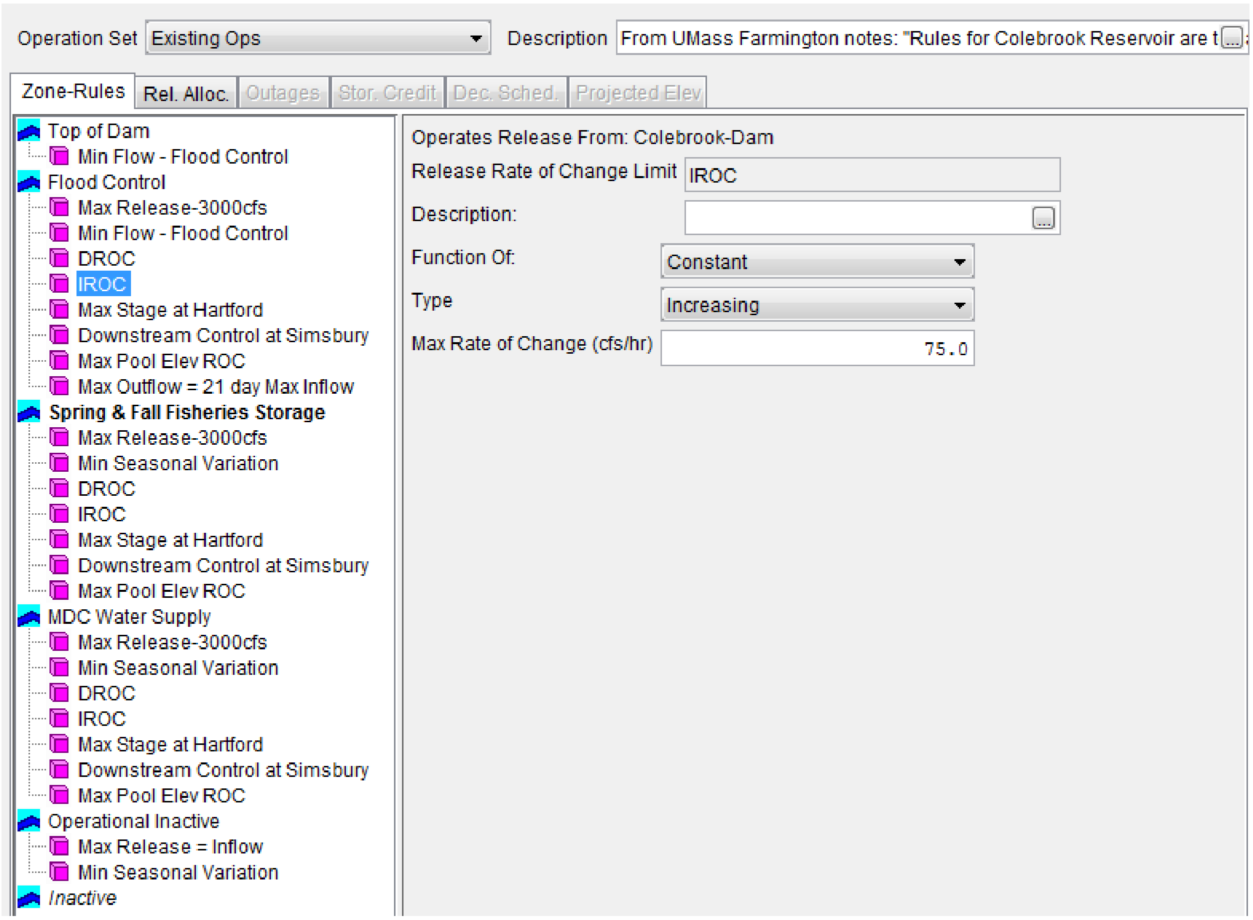


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Increasing-ROC

5. *Max Stage at Hartford*

Figure 12 shows the content of “Max Stage at Hartford” rule. This rule represents the maximum allowable release from dam as a function of previous day stage at Hartford. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

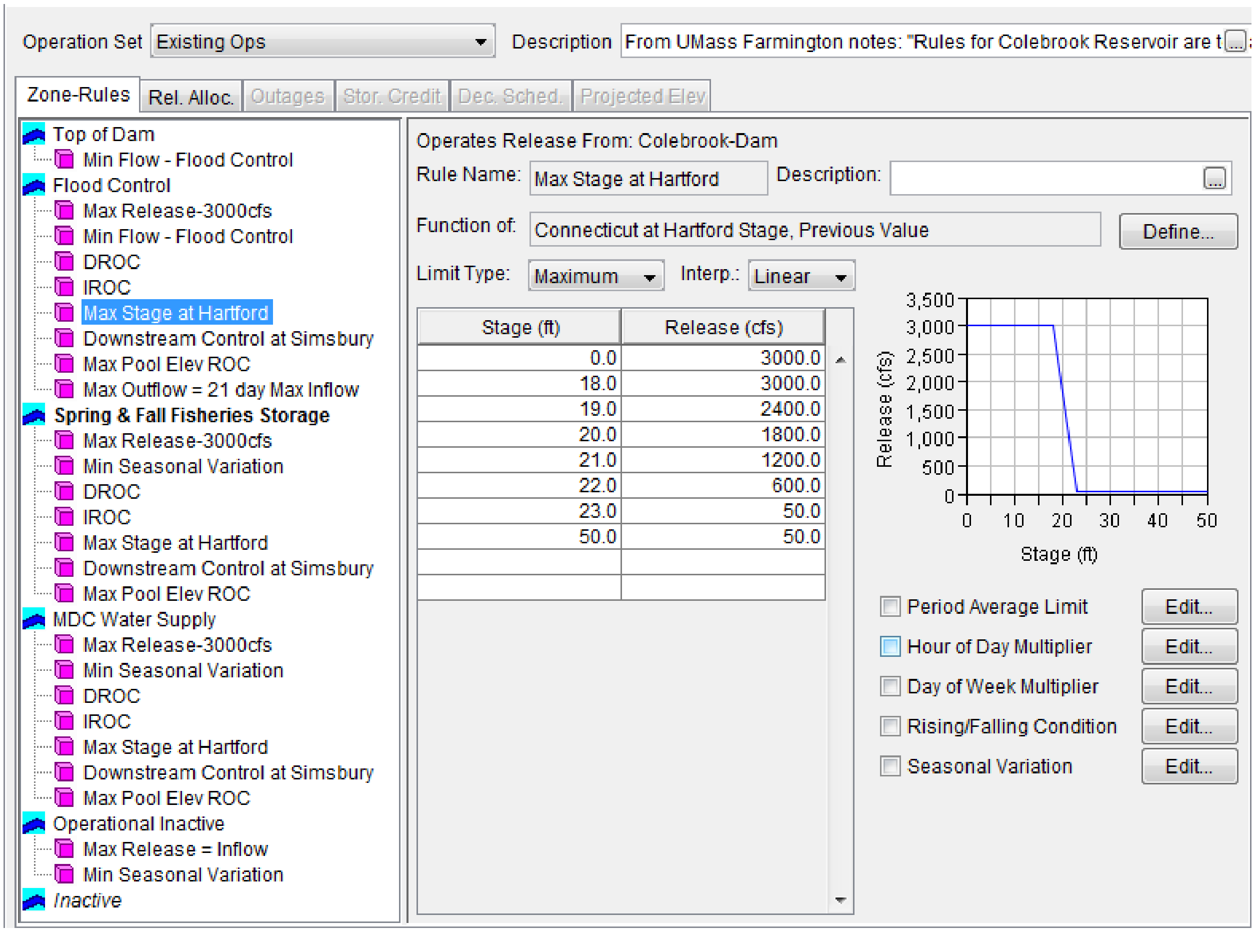


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max stage at Hartford

6. *Downstream Control at Simsbury*

Figure 13 shows the content of "Downstream Control at Simsbury" rule. This rule shows the maximum allowable flow at the Farmington at Simsbury point downstream.

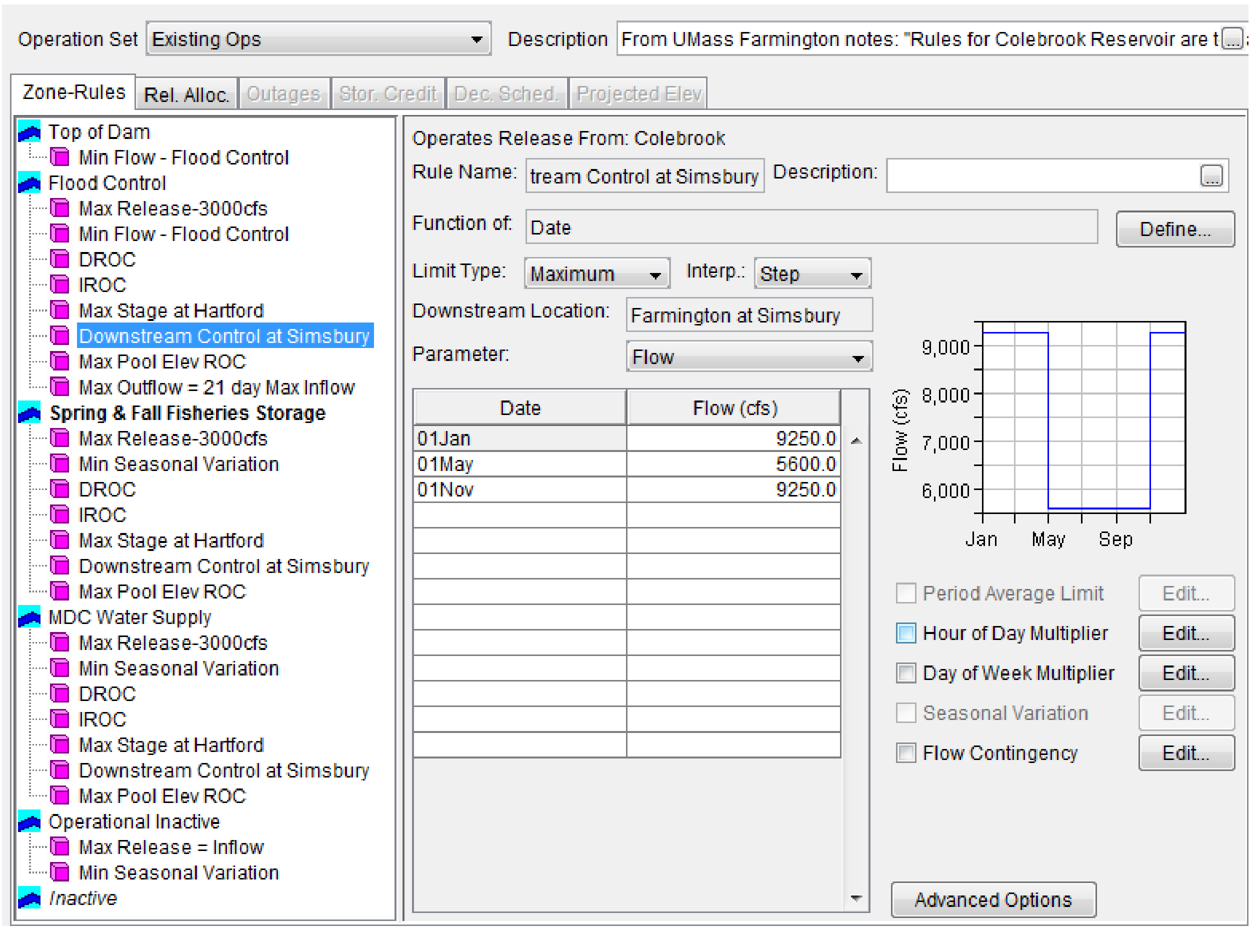


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Downstream Control at simsbury

7. *Max Pool Elev ROC*

Figure 14 shows the content of “Max pool Elev ROC” rule. This rule shows the maximum allowable decreasing rate of pool elevation change.

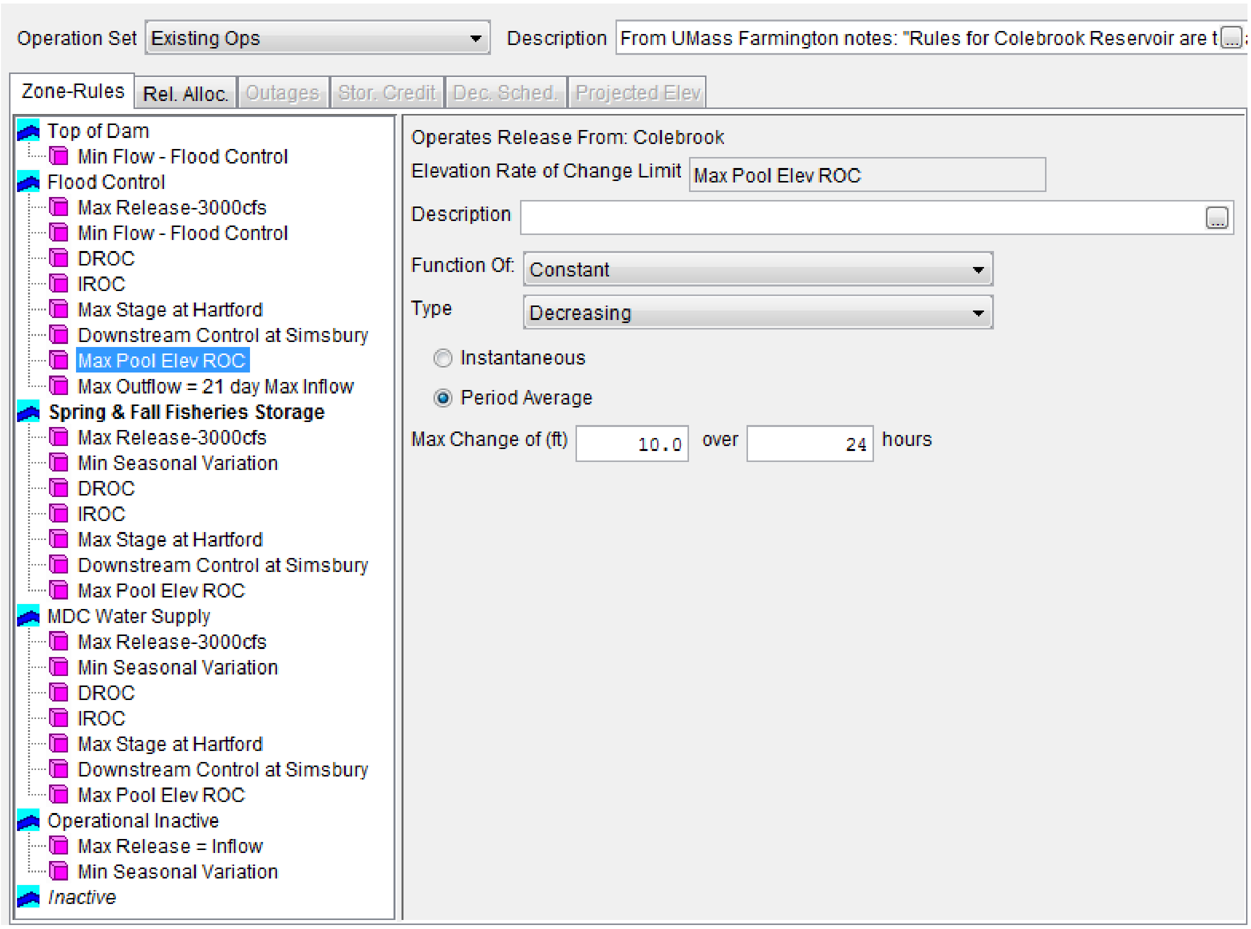


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Pool Elev ROC

8. Max Outflow equals 21 day Max Inflow

Figure 15 shows the content of "Max Outflow equals 21 day Max Inflow" rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

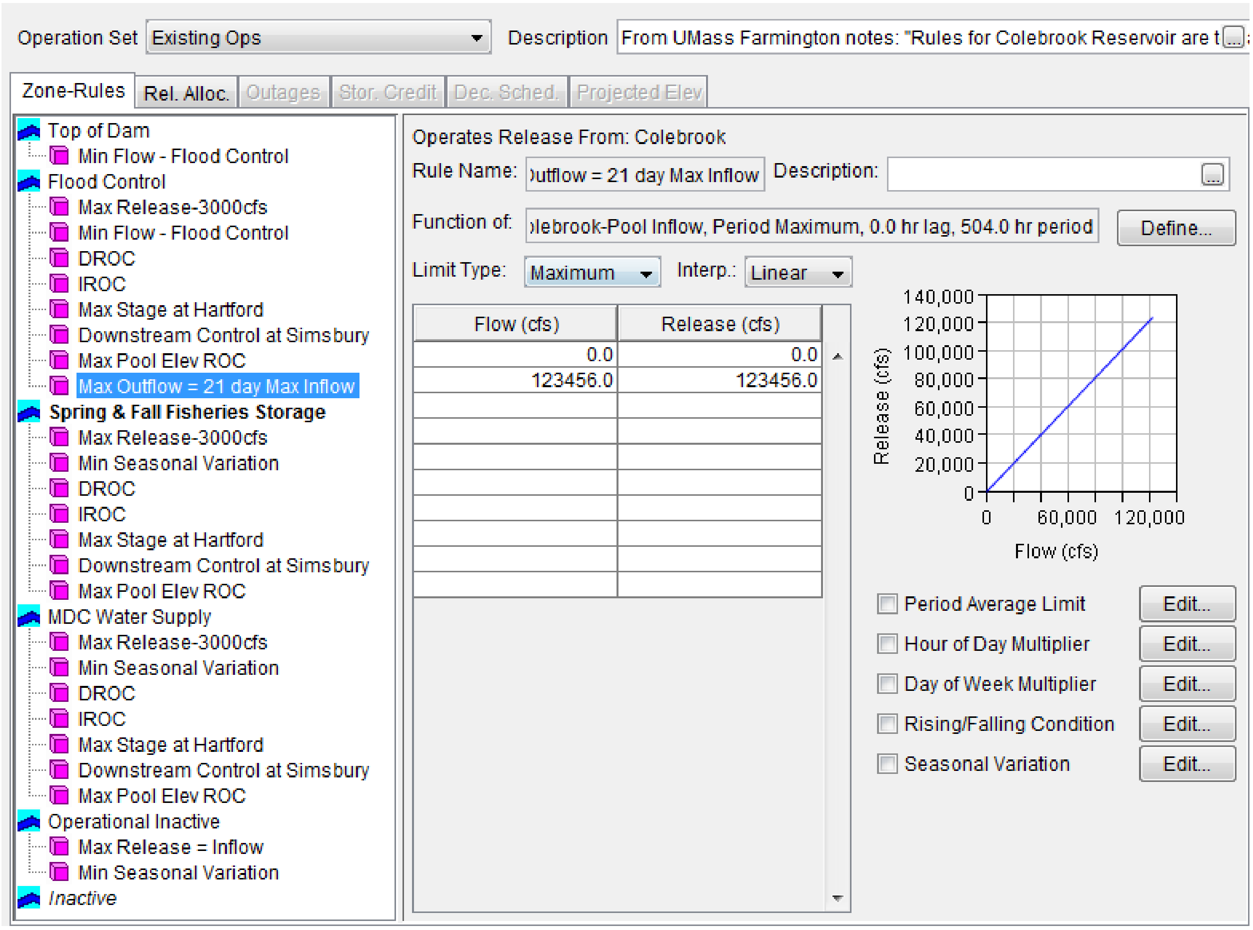


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals 21 day Max Inflow

9. *Min Seasonal Variation*

Figure 16 shows the content of “Min Seasonal Variation” rule. This rule shows the minimum release from dam as a function of inflow for different months.

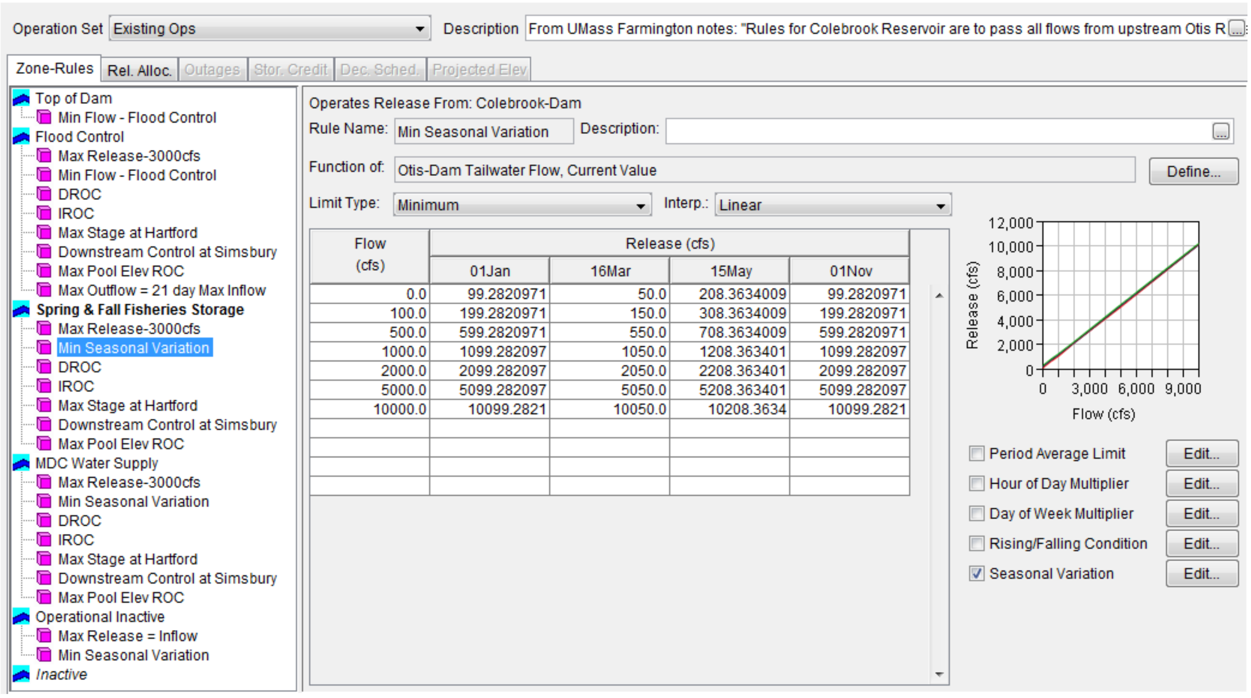


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Seasonal Variation

10. *Max release=Inflow*

Figure 17 shows the content of "Min Flow-Flood Control" rule. This rule releases total inflow from dam when the pool is in Operational Inactive zone.

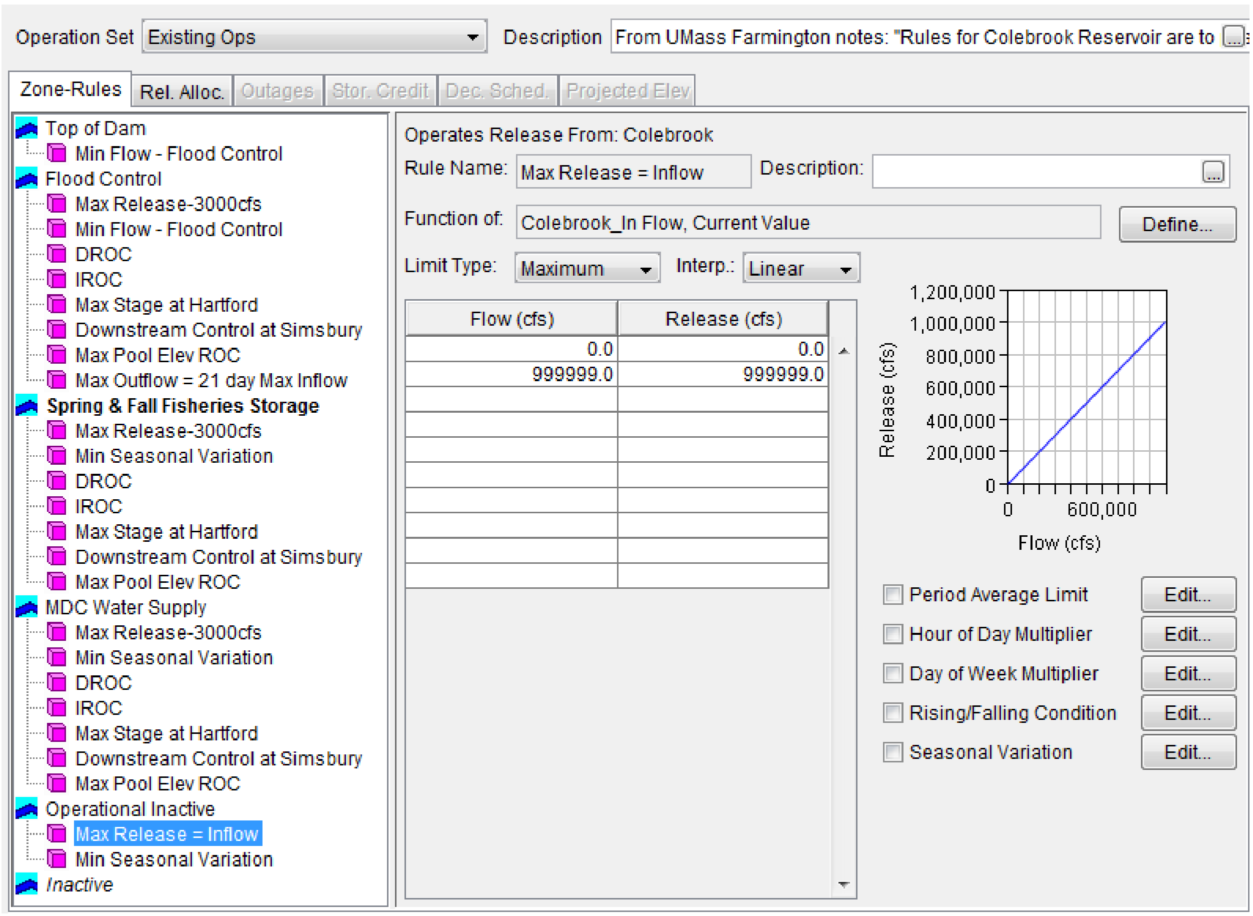


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow-Flood Control

Comerford

I. Overview

Comerford dam is located on the Connecticut River mainstem in the towns of Monroe, New Hampshire, and Barnet, Vermont. It is owned and operated by TransCanada Hydro Northeast Inc. as part of the 15 Mile Falls project for hydropower generation on a peaking, seasonal storage basis.

Figure 1 shows the location of Comerford dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Comerford dam.

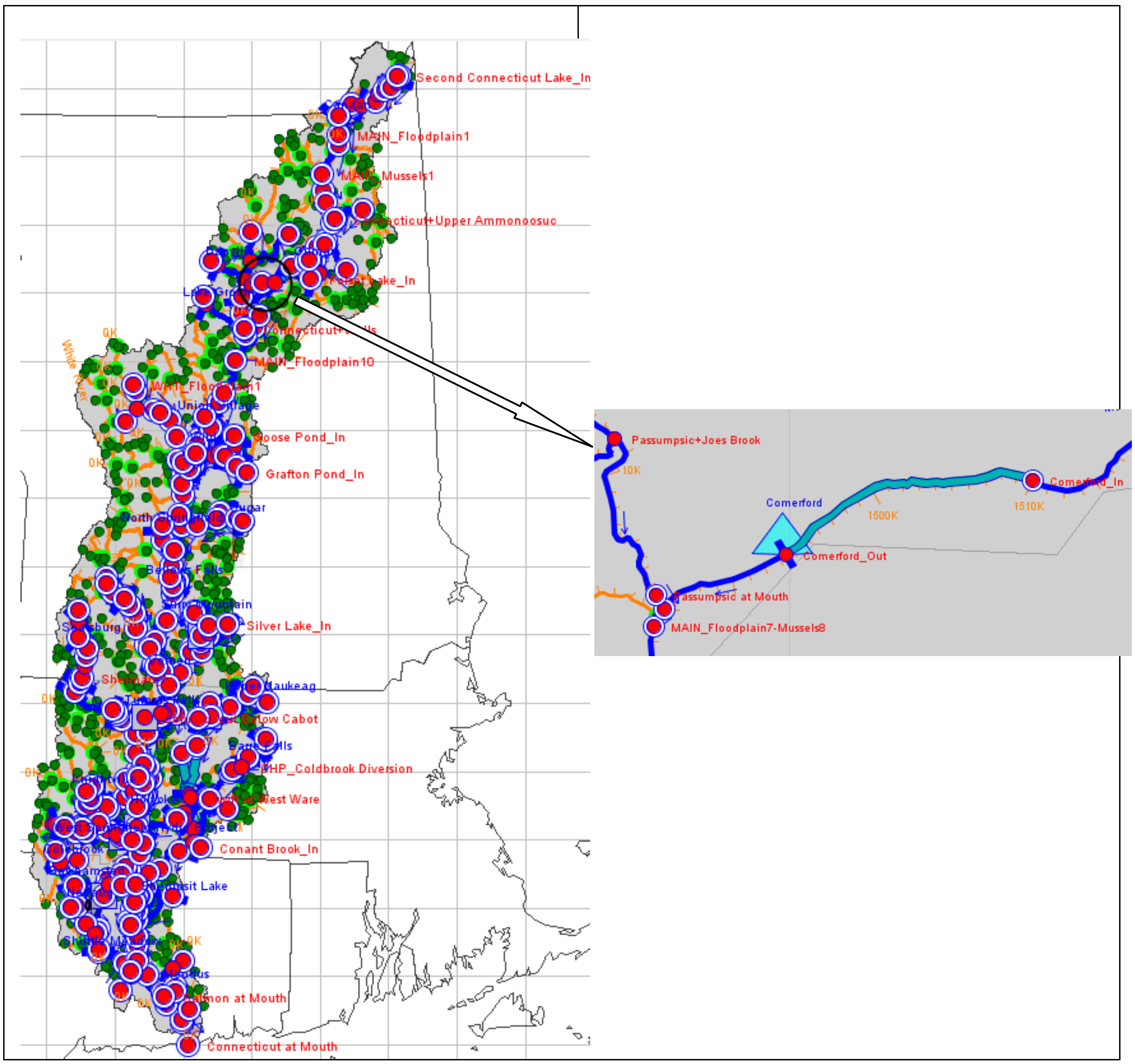


Figure 1: HEC-ResSim Map Display Showing Location of Comerford dam

Figure 2: Photo of Comerford dam.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[20]. The dam consists of three types of outlets: (1) uncontrolled stanchion Bays, and (2) uncontrolled Flashboard Bays, and (3) power plant as shown in Figure 4.

[20] Data provided by TransCanada

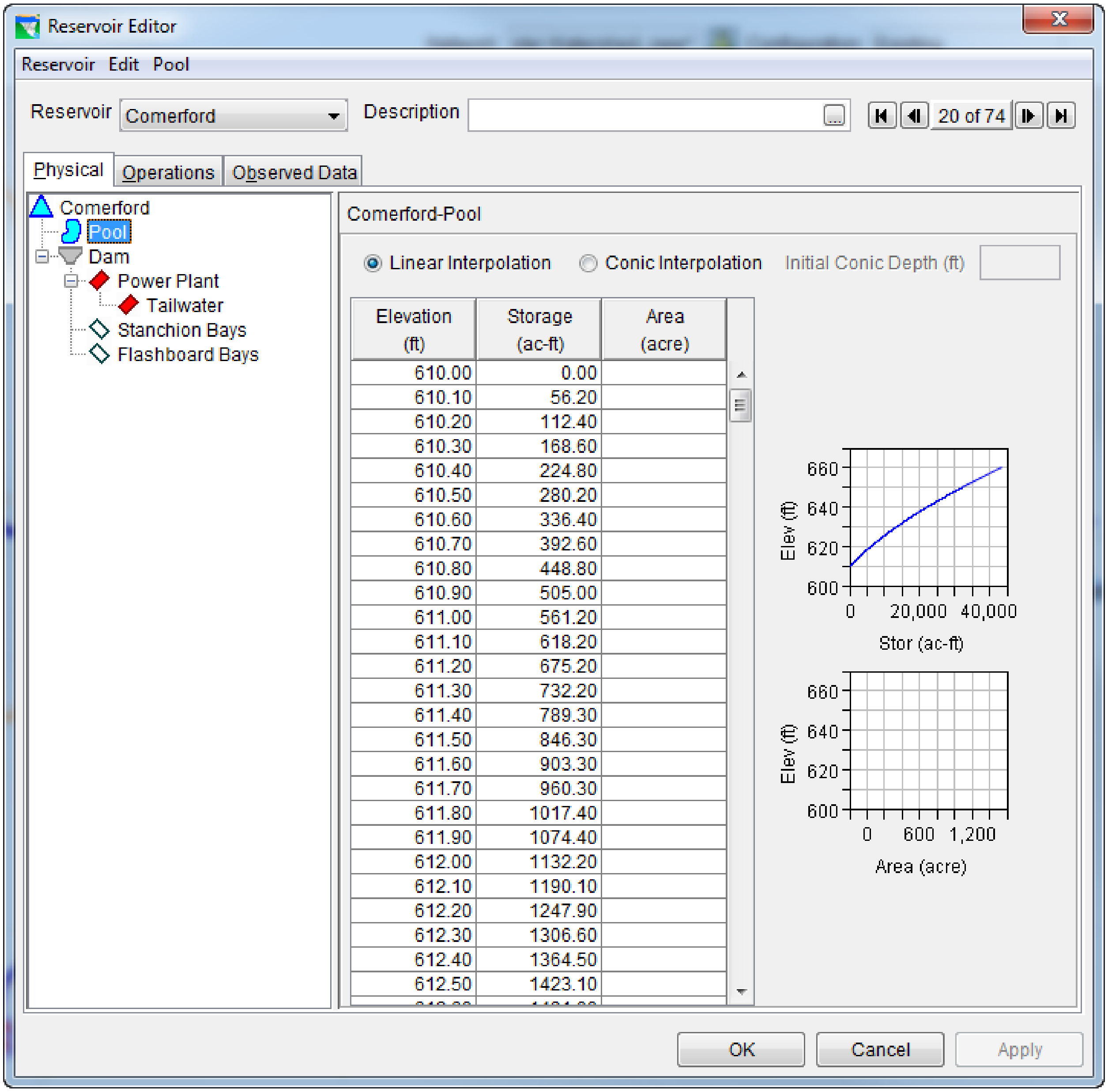


Figure 3: Reservoir Editor: Physical Tab -- Pool

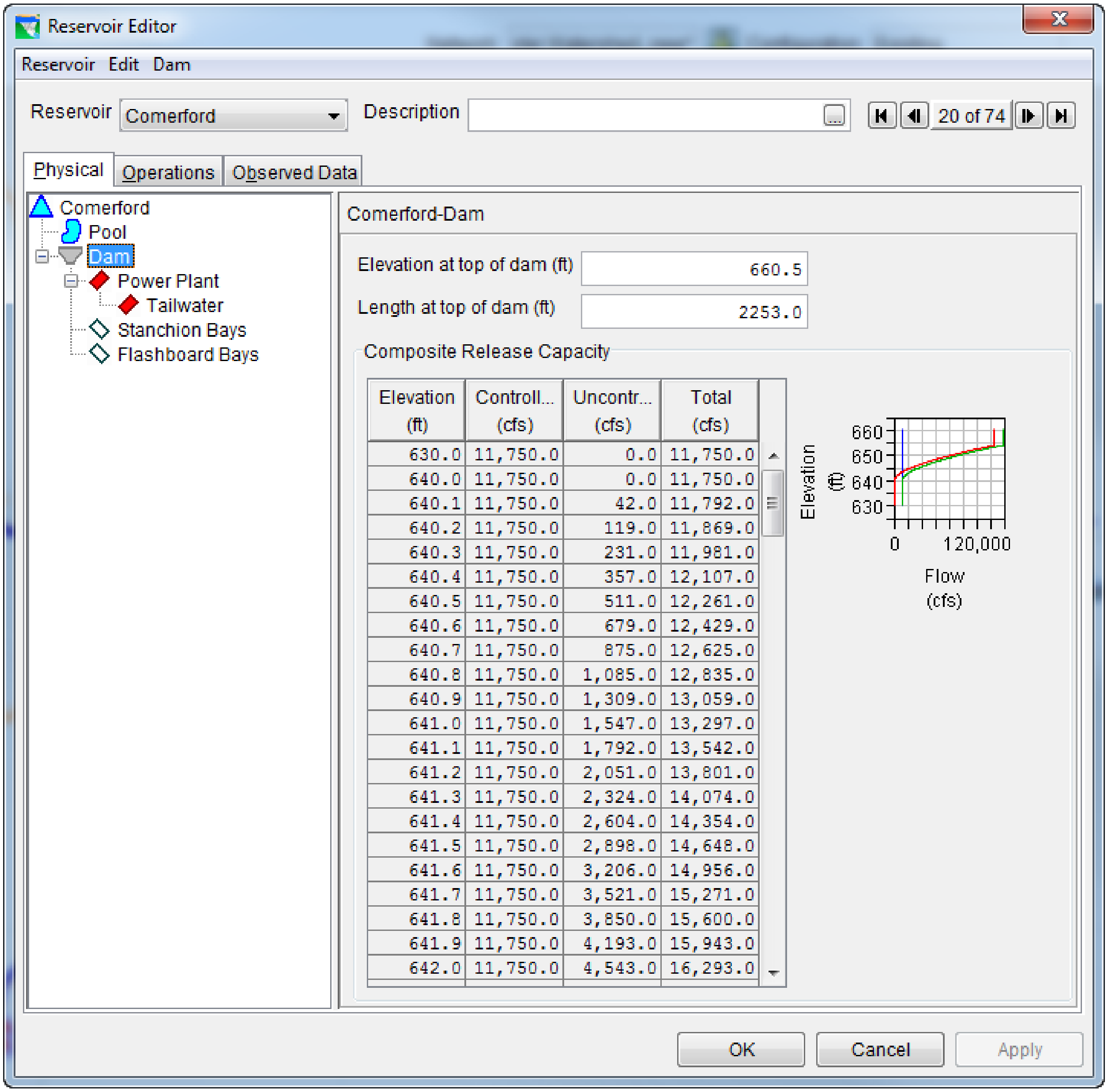


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Comerford's "Existing Ops" operational zones, which consist of zones of Top of dam (660.5 ft), Below Top of dam (650 ft), Conservation (635-648 ft), and Inactive zone (624 ft)[1].

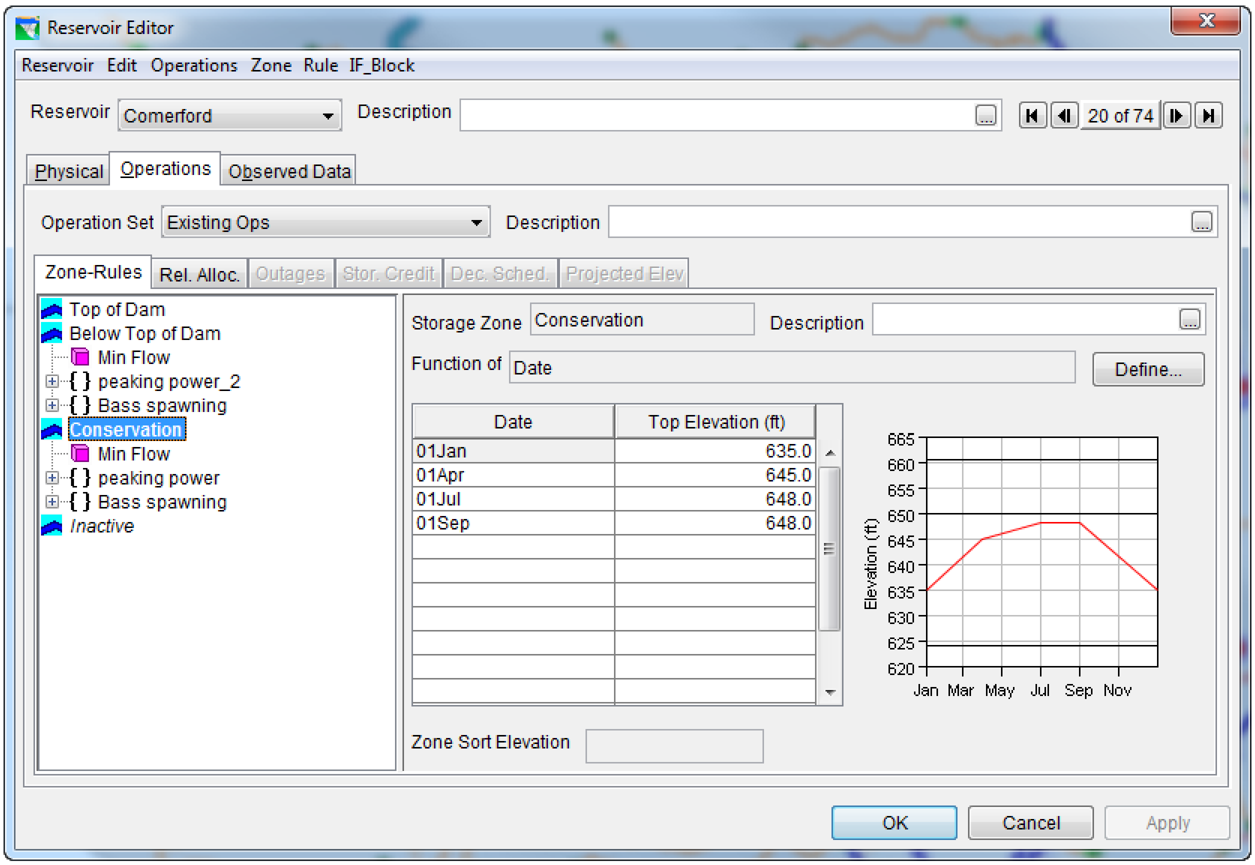


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[21].

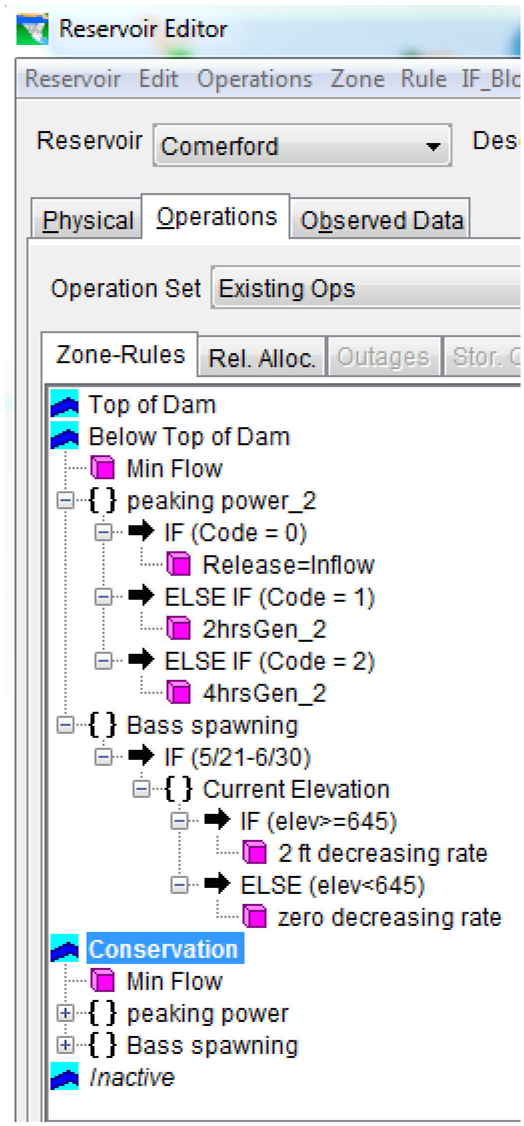


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[21] TransCanada. Connecticut River Operational Constraints. 2012.

C. Rule Descriptions

1. Min Flow

Figure 7 shows the content of “Min Flow” rule. This rule shows the minimum release from dam.

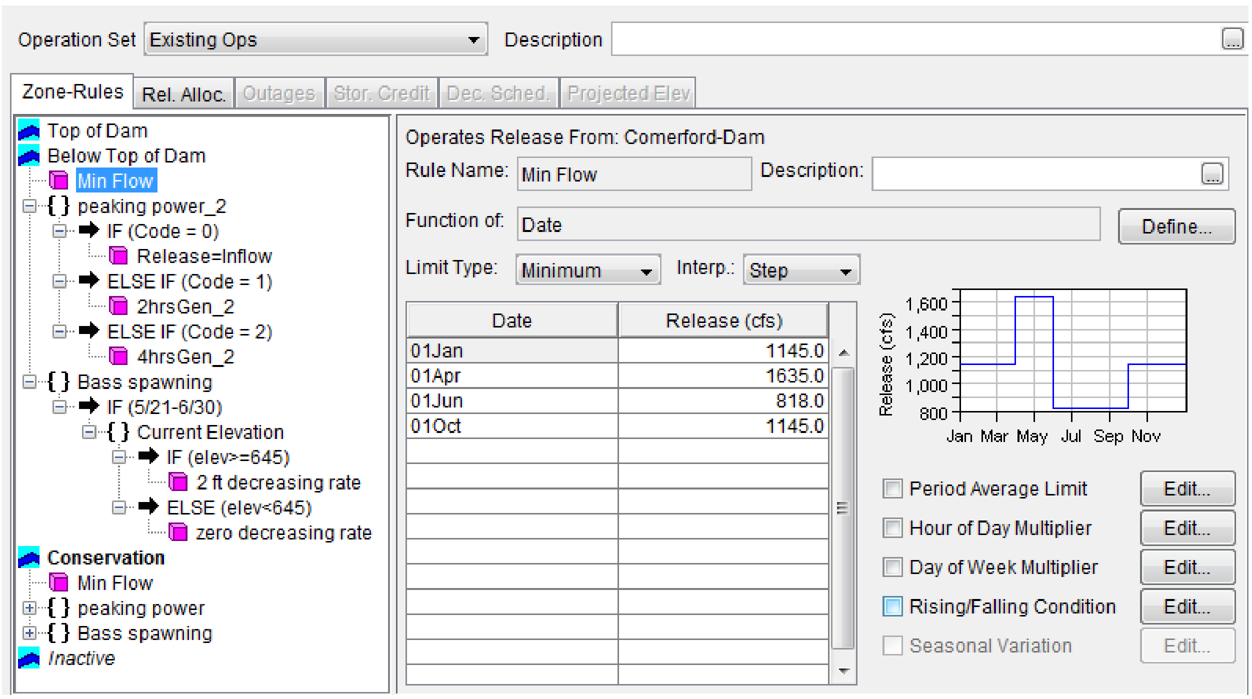
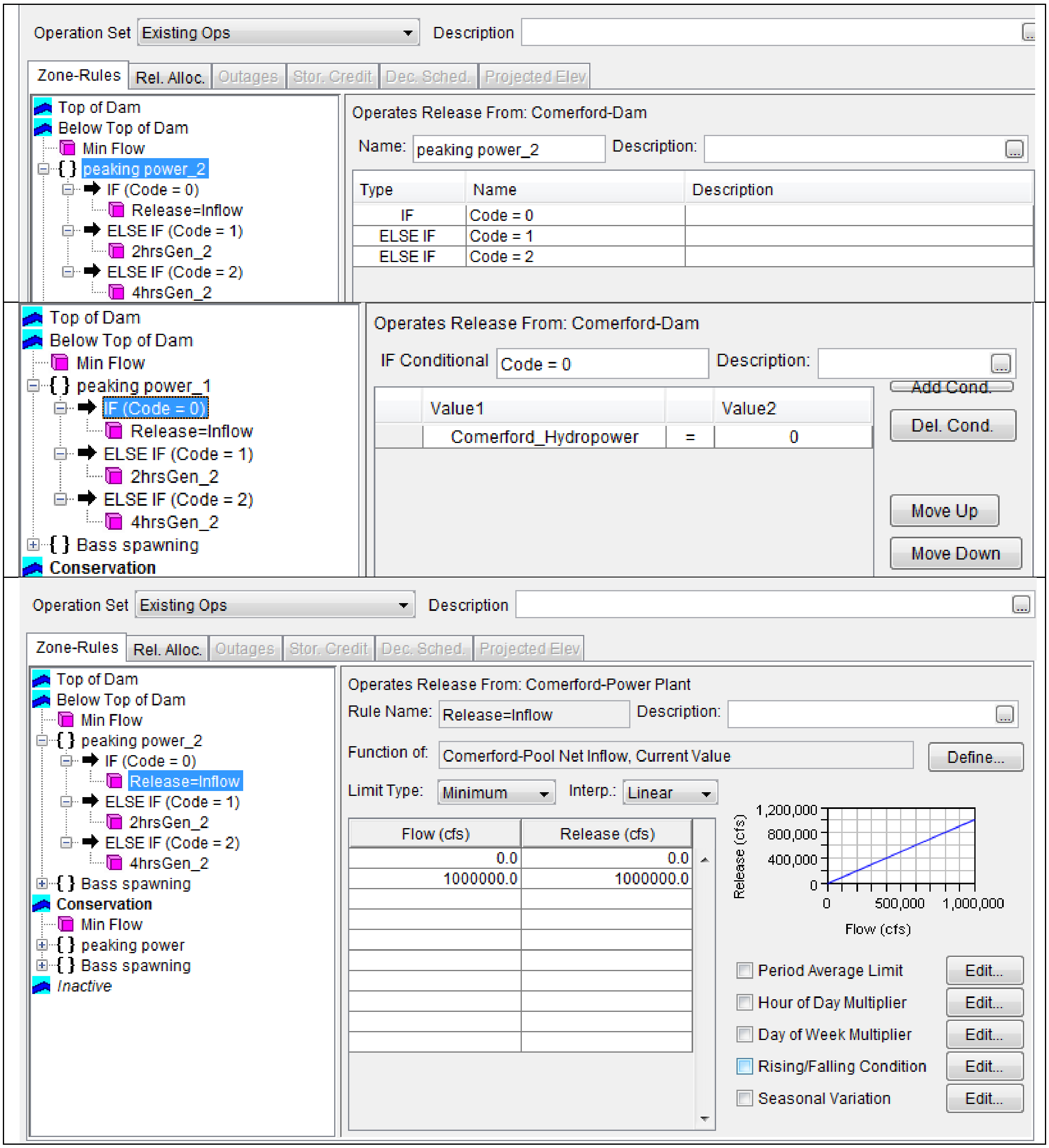
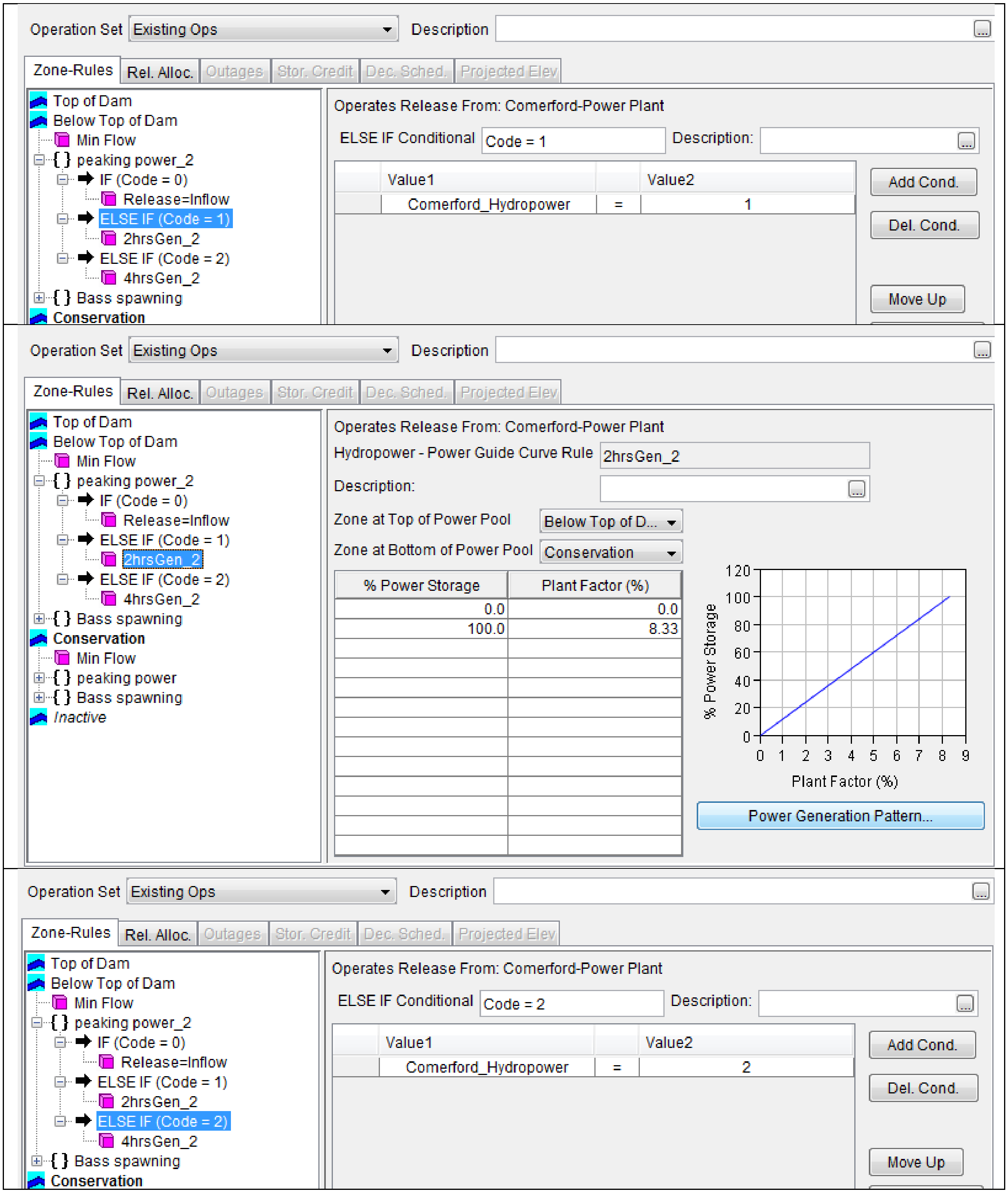


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow

2. Peaking power_2

Figure 8 shows the content of "peaking power_2" rule. This rule represents the peaking power strategy applied for Comerford dam.




Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of Dam
Below Top of Dam
Min Flow
peaking power_2
IF (Code = 0)
Release=Inflow
ELSE IF (Code = 1)
2hrsGen_2
ELSE IF (Code = 2)
4hrsGen_2
Bass spawning
Conservation
Operates Release From: Comerford-Power Plant
ELSE IF Conditional
Code = 1
Description:
Value1
Value2
Comerford_Hydropower
=
1
Add Cond.
Del. Cond.
Move Up
Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of Dam
Below Top of Dam
Min Flow
peaking power_2
IF (Code = 0)
Release=Inflow
ELSE IF (Code = 1)
2hrsGen_2
ELSE IF (Code = 2)
4hrsGen_2
Bass spawning
Conservation
Min Flow
peaking power
Bass spawning
Inactive
Operates Release From: Comerford-Power Plant
Hydropower - Power Guide Curve Rule
2hrsGen_2
Description:
Zone at Top of Power Pool
Below Top of D...
Zone at Bottom of Power Pool
Conservation
% Power Storage
Plant Factor (%)
0.0
0.0
100.0
8.33
120
100
80
60
40
20
0
% Power Storage
0 1 2 3 4 5 6 7 8 9
Plant Factor (%)
Power Generation Pattern...
Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of Dam
Below Top of Dam
Min Flow
peaking power_2
IF (Code = 0)
Release=Inflow
ELSE IF (Code = 1)
2hrsGen_2
ELSE IF (Code = 2)
4hrsGen_2
Bass spawning
Conservation
Operates Release From: Comerford-Power Plant
ELSE IF Conditional
Code = 2
Description:
Value1
Value2
Comerford_Hydropower
=
2
Add Cond.
Del. Cond.
Move Up

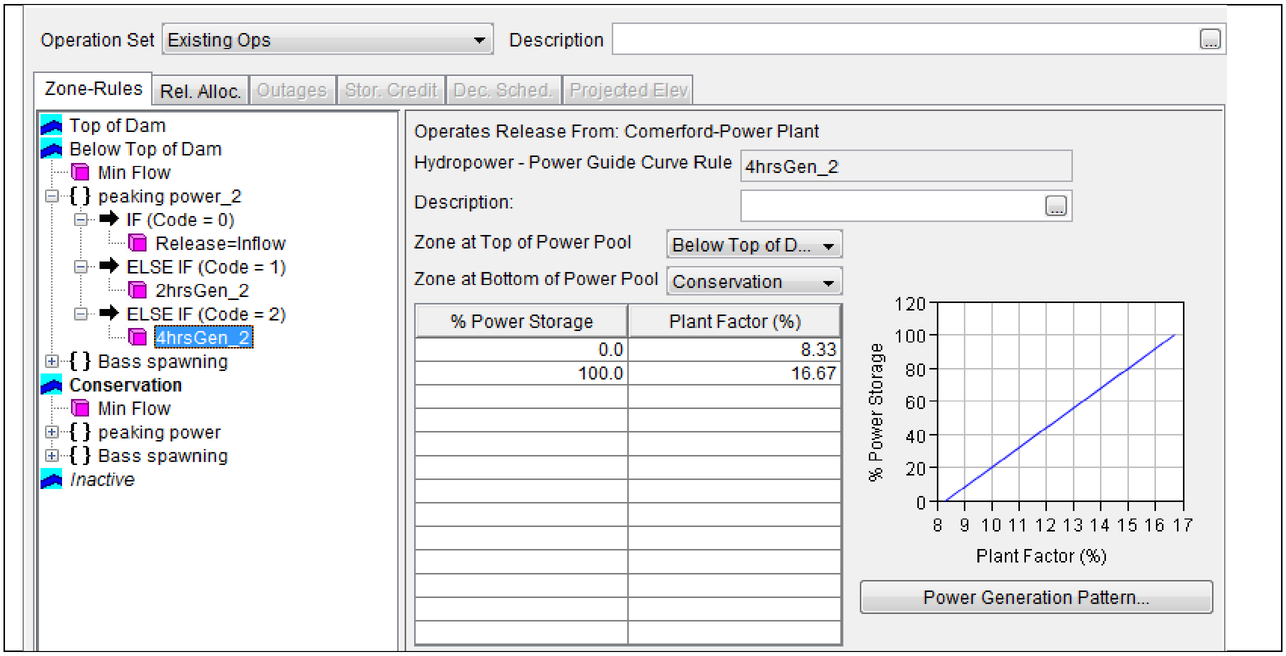


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – peaking power_2

Figure 9 describes the definition of codes used in the Comerford_Volume state variable. The code is summing up the current Inflow and previous storage in each time step, compare it to the volume needed for generating 2 and 4 hours power and to the spillway storage minus inactive storage and then decide how much to release.

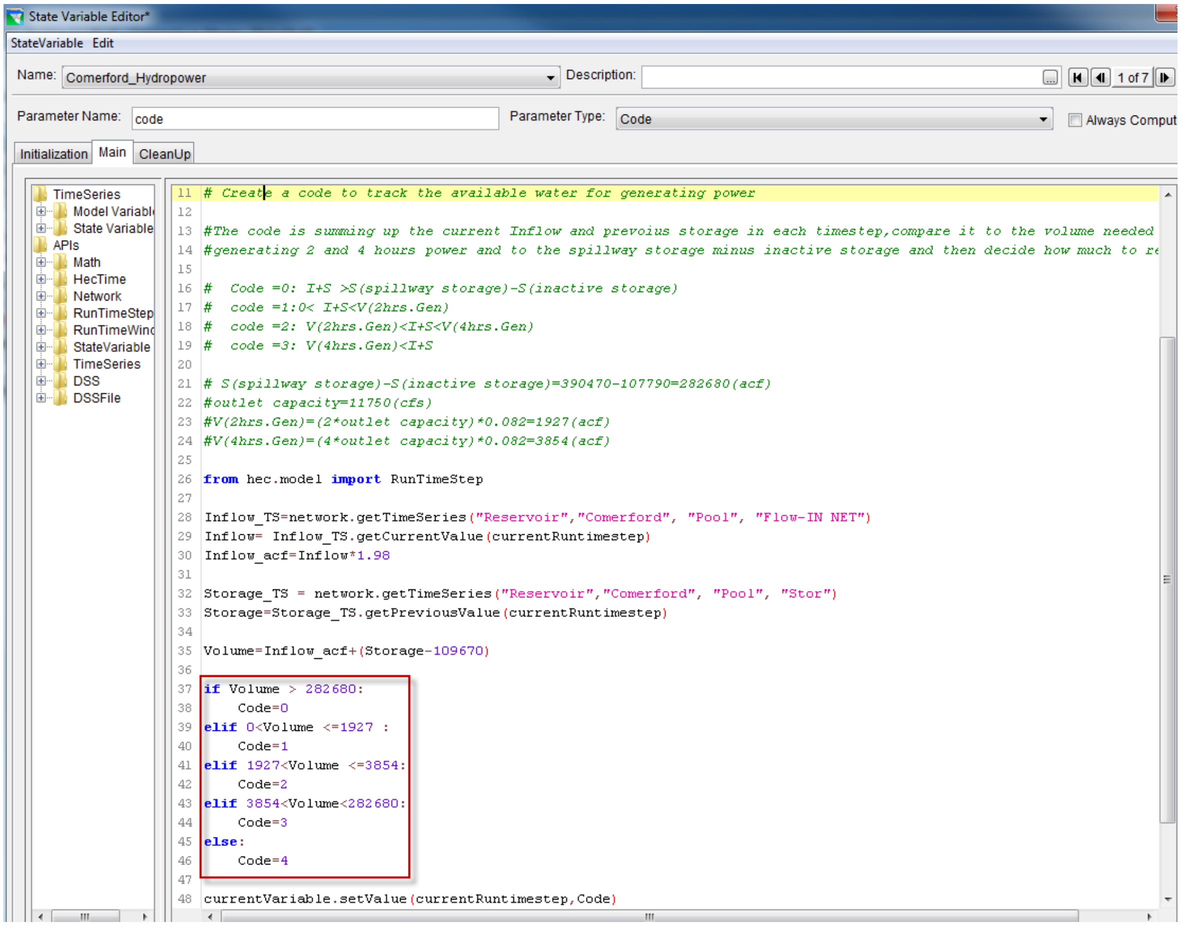
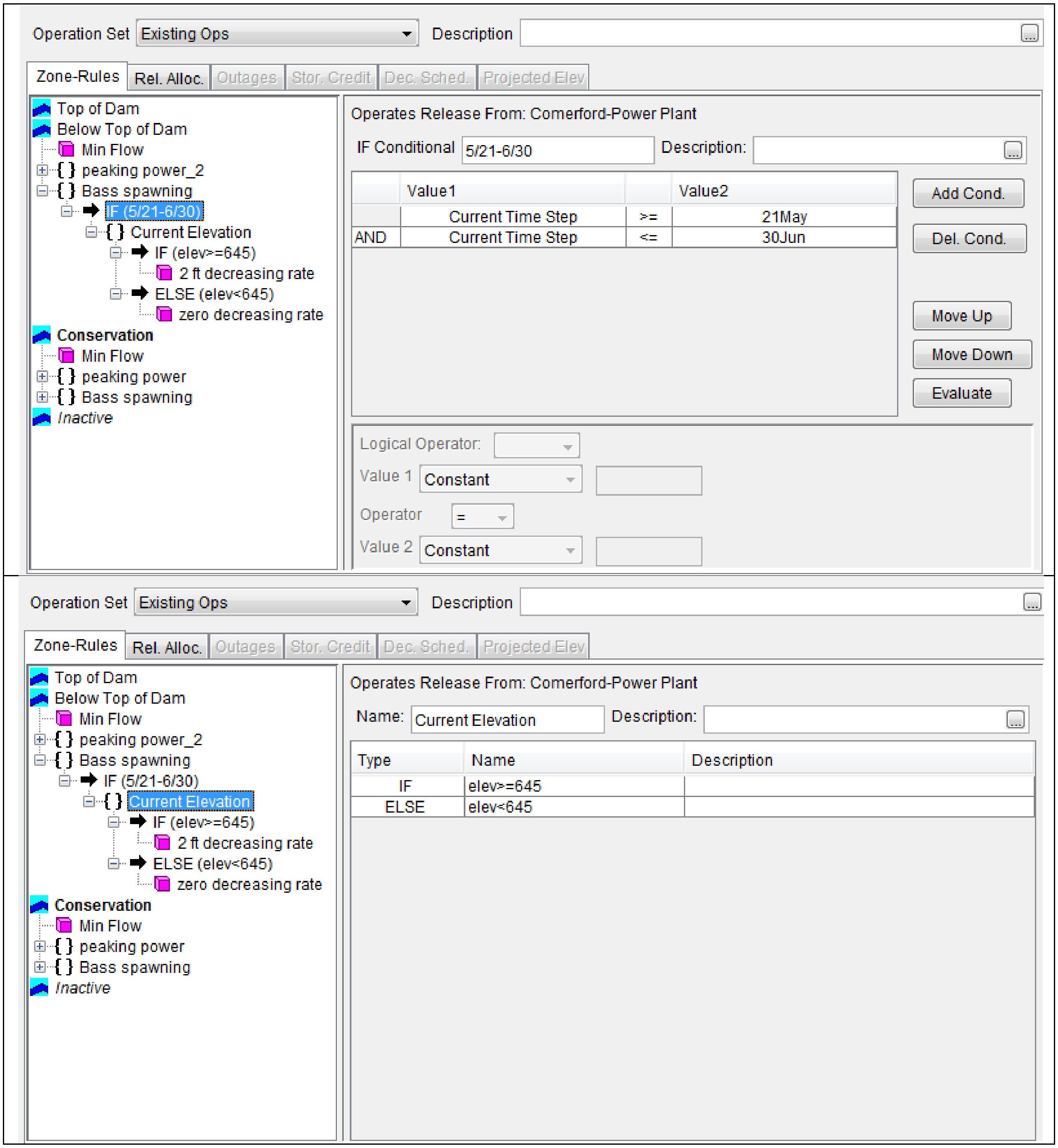
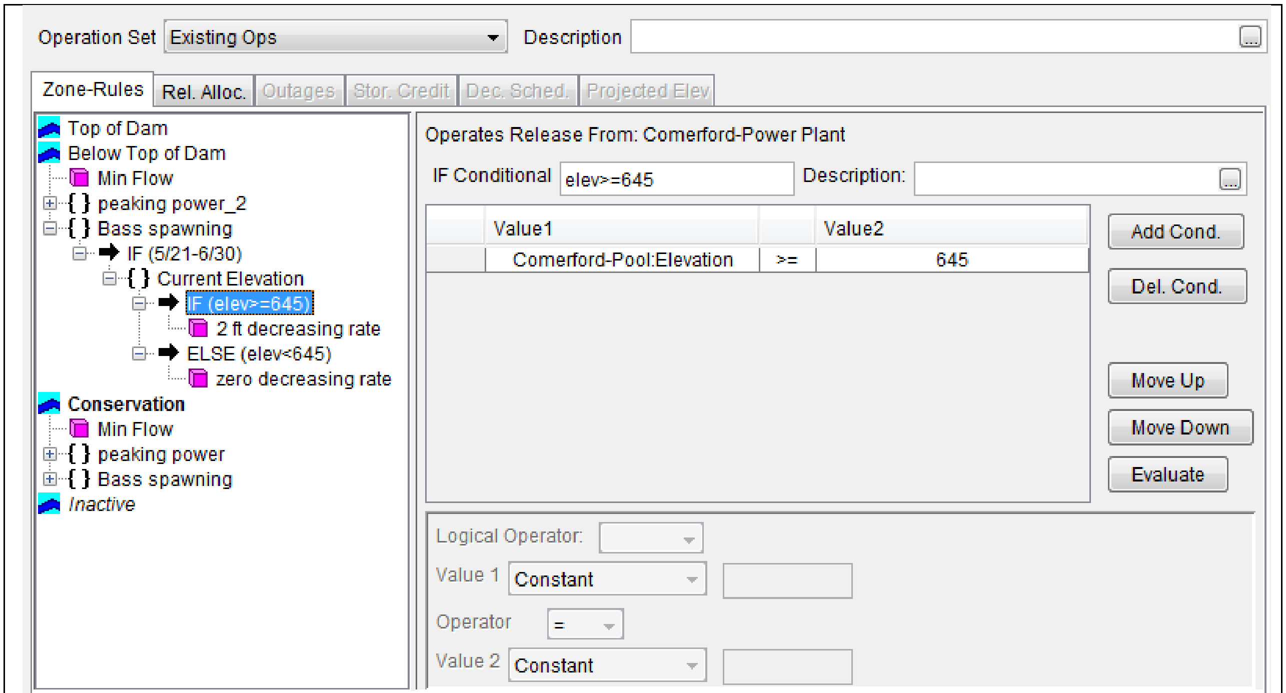


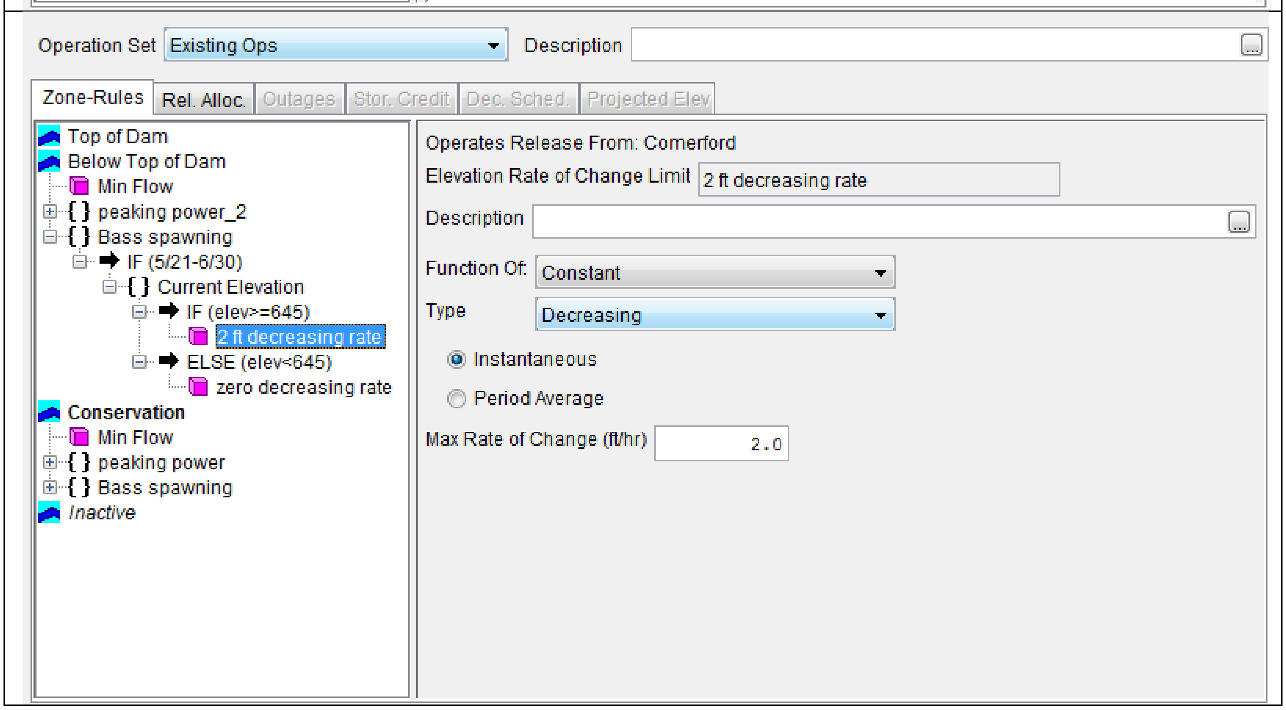
Figure 9: State Variable Editor: Comerford_Volume

3. *Bass spawning*

Figure 10 shows the content of "Bass spawning" rule. This rule shows the different maximum elevation rate of change for elevations greater and less than 645 feet during 21May-30June.




Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of Dam
Below Top of Dam
Min Flow
peaking power_2
Bass spawning
IF (5/21-6/30)
Current Elevation
IF (elev>=645)
2 ft decreasing rate
ELSE (elev<645)
zero decreasing rate
Conservation
Min Flow
peaking power
Bass spawning
Inactive
Operates Release From: Comerford-Power Plant
IF Conditional
elev>=645
Description:
Value1
Value2
Comerford-Pool:Elevation
>=
645
Add Cond.
Del. Cond.
Move Up
Move Down
Evaluate
Logical Operator:
Value 1
Constant
Operator
=
Value 2
Constant


Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of Dam
Below Top of Dam
Min Flow
peaking power_2
Bass spawning
IF (5/21-6/30)
Current Elevation
IF (elev>=645)
2 ft decreasing rate
ELSE (elev<645)
zero decreasing rate
Conservation
Min Flow
peaking power
Bass spawning
Inactive
Operates Release From: Comerford
Elevation Rate of Change Limit
2 ft decreasing rate
Description
Function Of:
Constant
Type
Decreasing
Instantaneous
Period Average
Max Rate of Change (ft/hr)
2.0

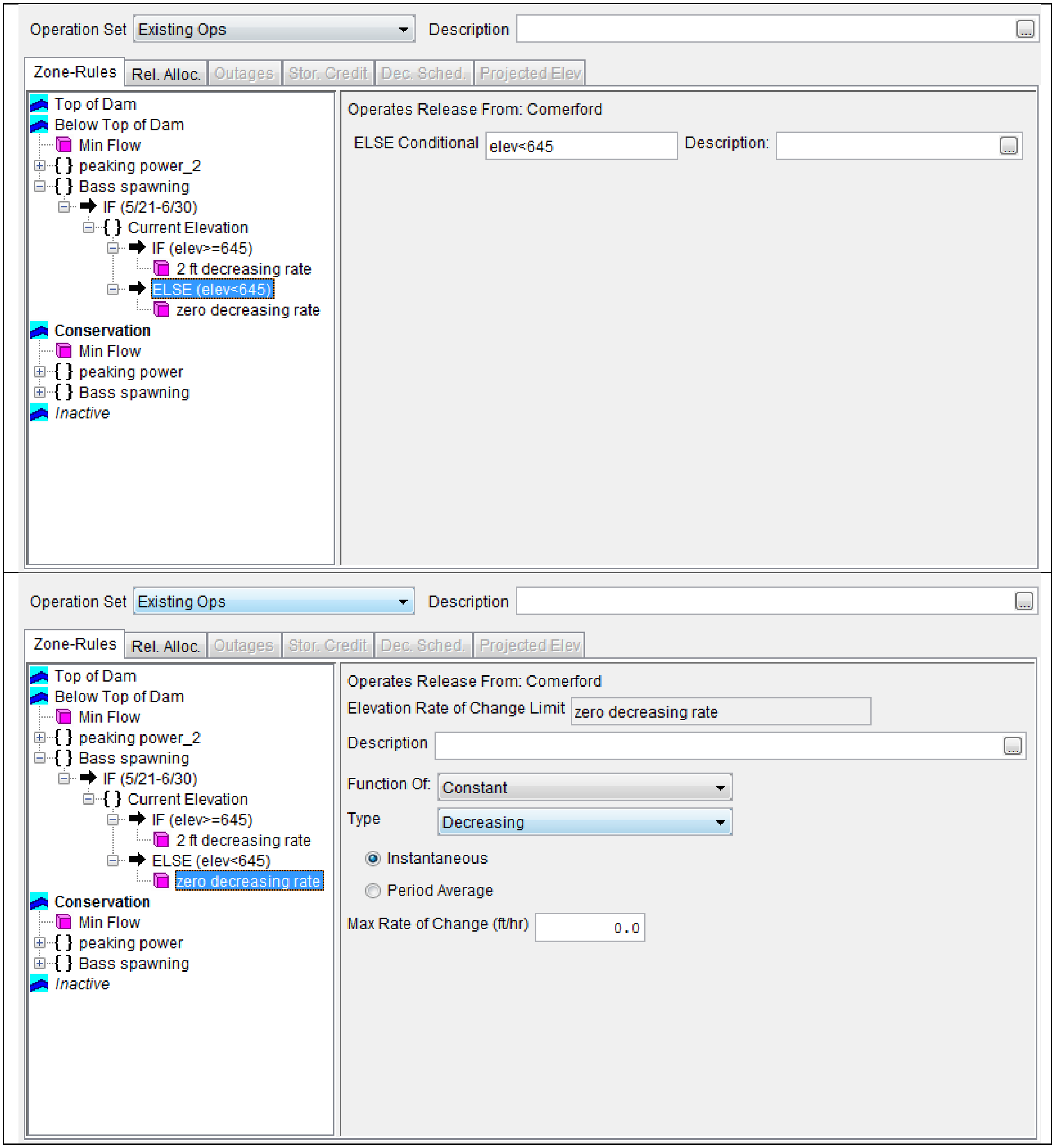


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Bass spawning

Conant Brook

I. Overview

Designed and constructed by the United States Army Corps of Engineers, this dam reduces flooding along the Quaboag, Chicopee, and Connecticut rivers. Construction of the project began in 1964 with completion in 1966. The Conant Brook Dam is located within the Chicopee River watershed. Unlike the other Corps operated flood control dams, Conant Brook is a completely uncontrolled structure..

Figure 1 shows the location of Conant Brook Dam as it is represented in the HEC-ResSim model. Figure 2 shows an aerial photo of the dam.

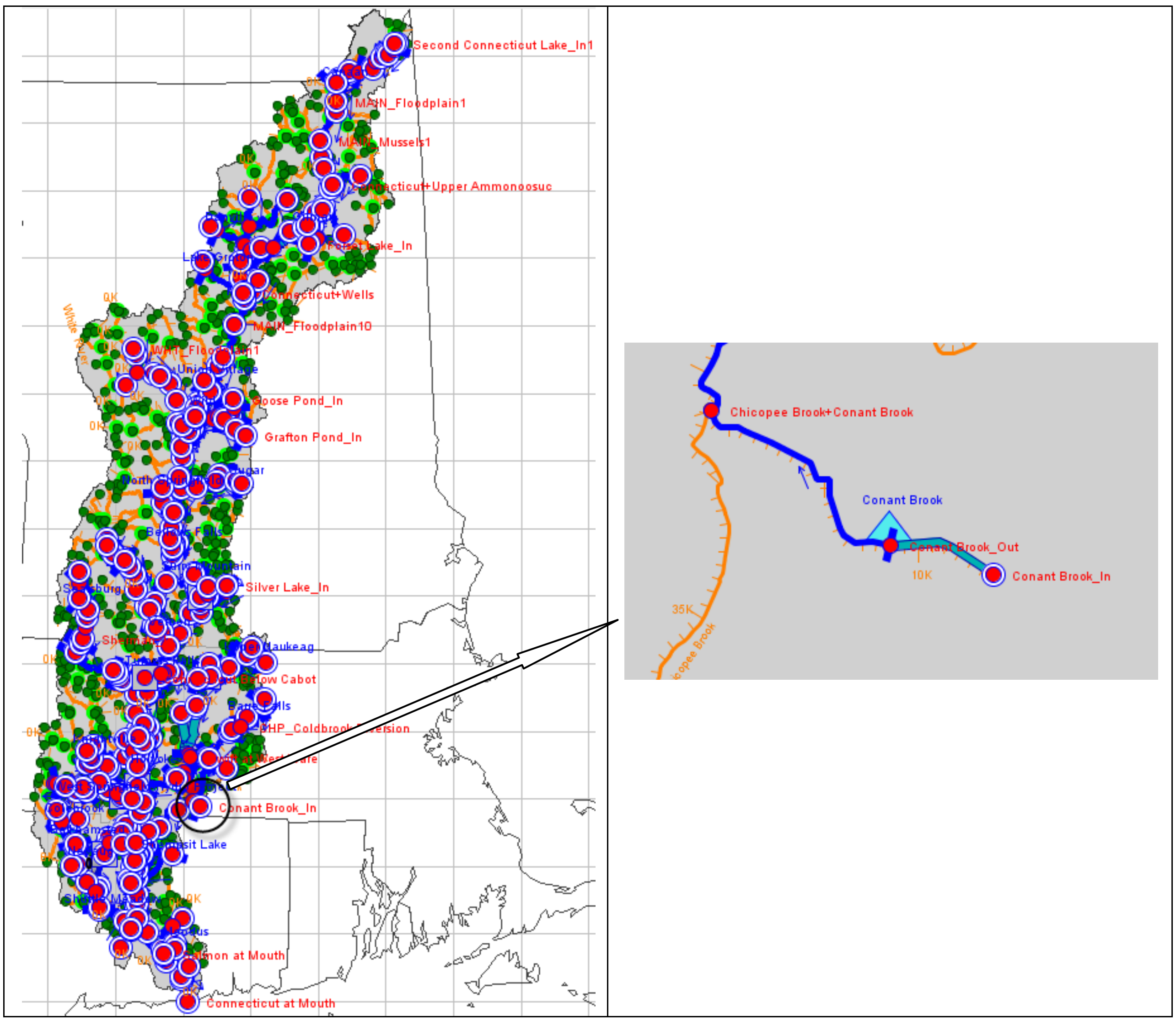


Figure 1: HEC-ResSim Map Display Showing Location of Conant Brook

Figure 2: Aerial photo of Conant Brook Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of an uncontrolled spillway and uncontrolled 36-inch un-gated conduit as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[22].

[22] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

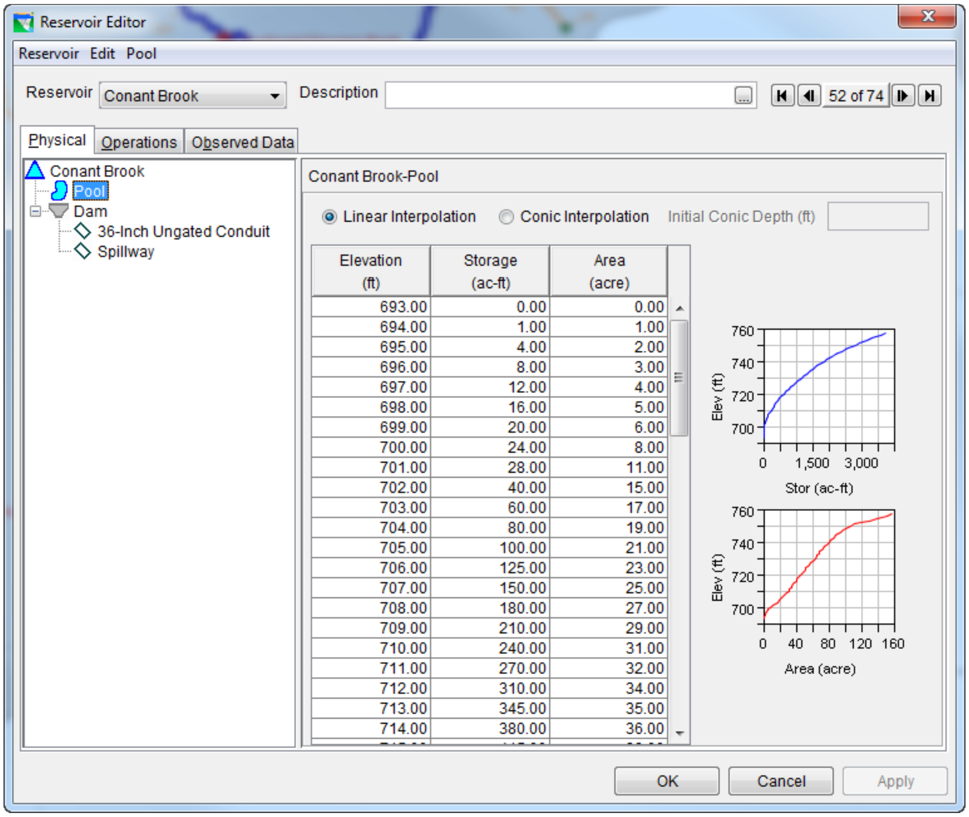


Figure 3: Reservoir Editor -- Physical Tab -- Pool

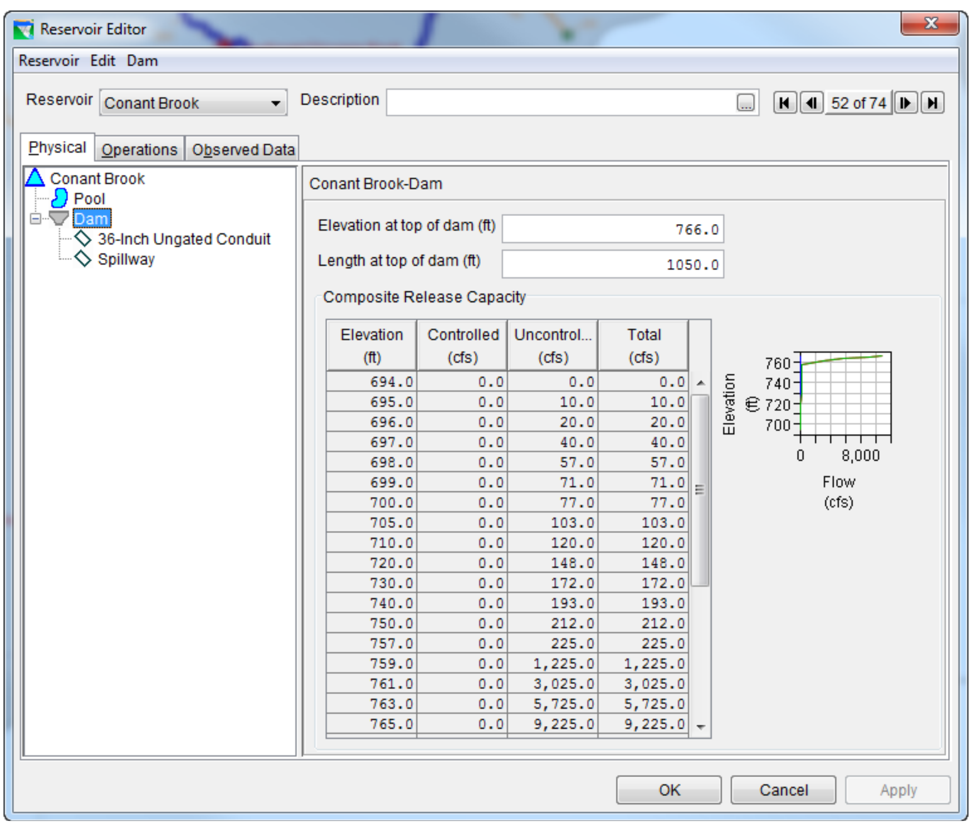


Figure 4: Reservoir Editor -- Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Conant Brook's "Existing Ops" operational zones, which consist of the zones Flood Control (757 ft), Conservation (696 ft), and Inactive (694 ft).

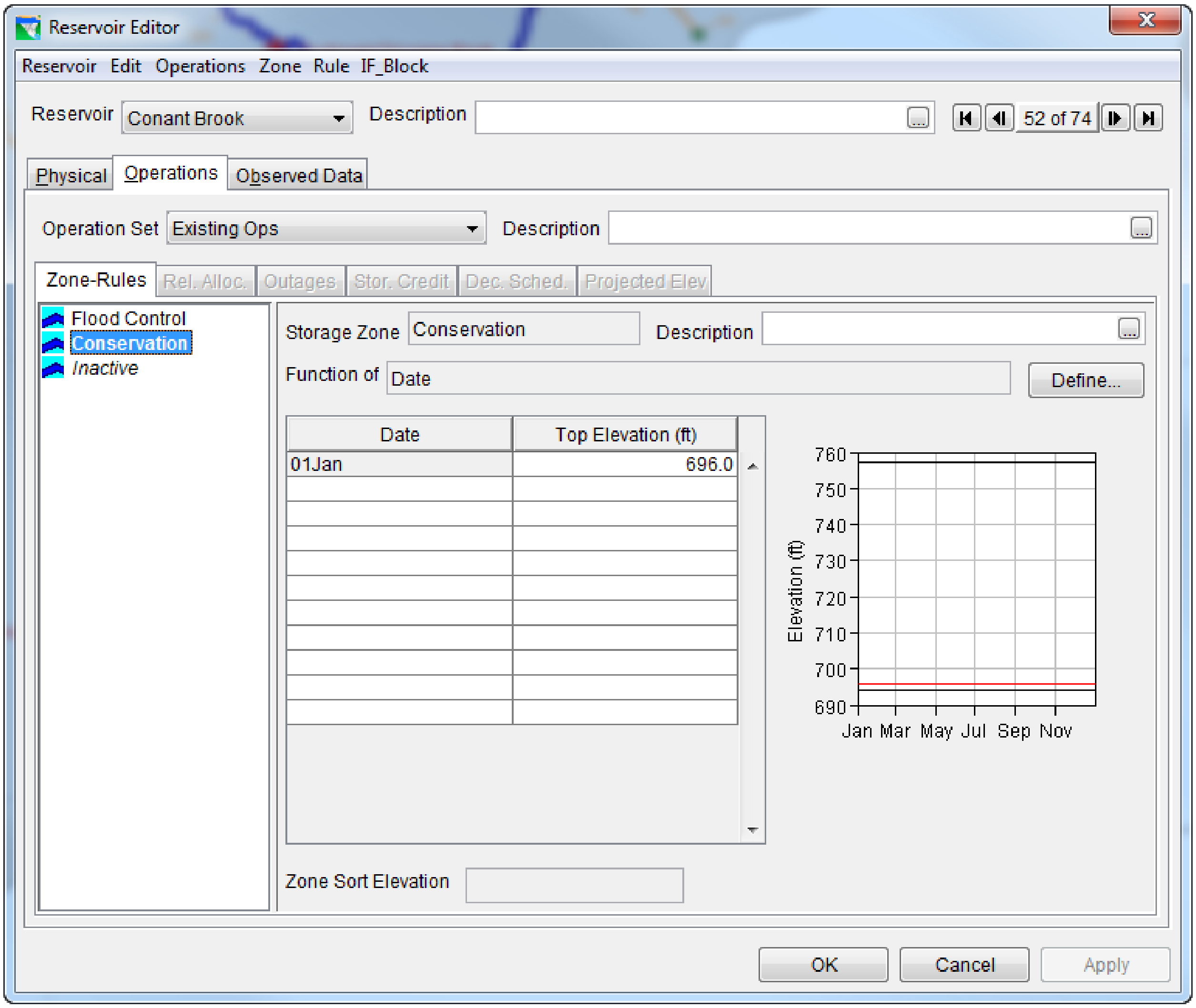


Figure 5: Reservoir Editor -- Operations Tab – Existing OpSet

B. Rule Illustrations

The operation set for Conant Brook has no operating rules making it a through flow reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Crescent Street

I. Overview

Crescent Street dam is a dam on the Millers River in Athol, MA. It is owned and operated by the L.S. Starrett Company and is used for hydropower generation.

Figure 1 shows the location of Crescent Street Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the dam.

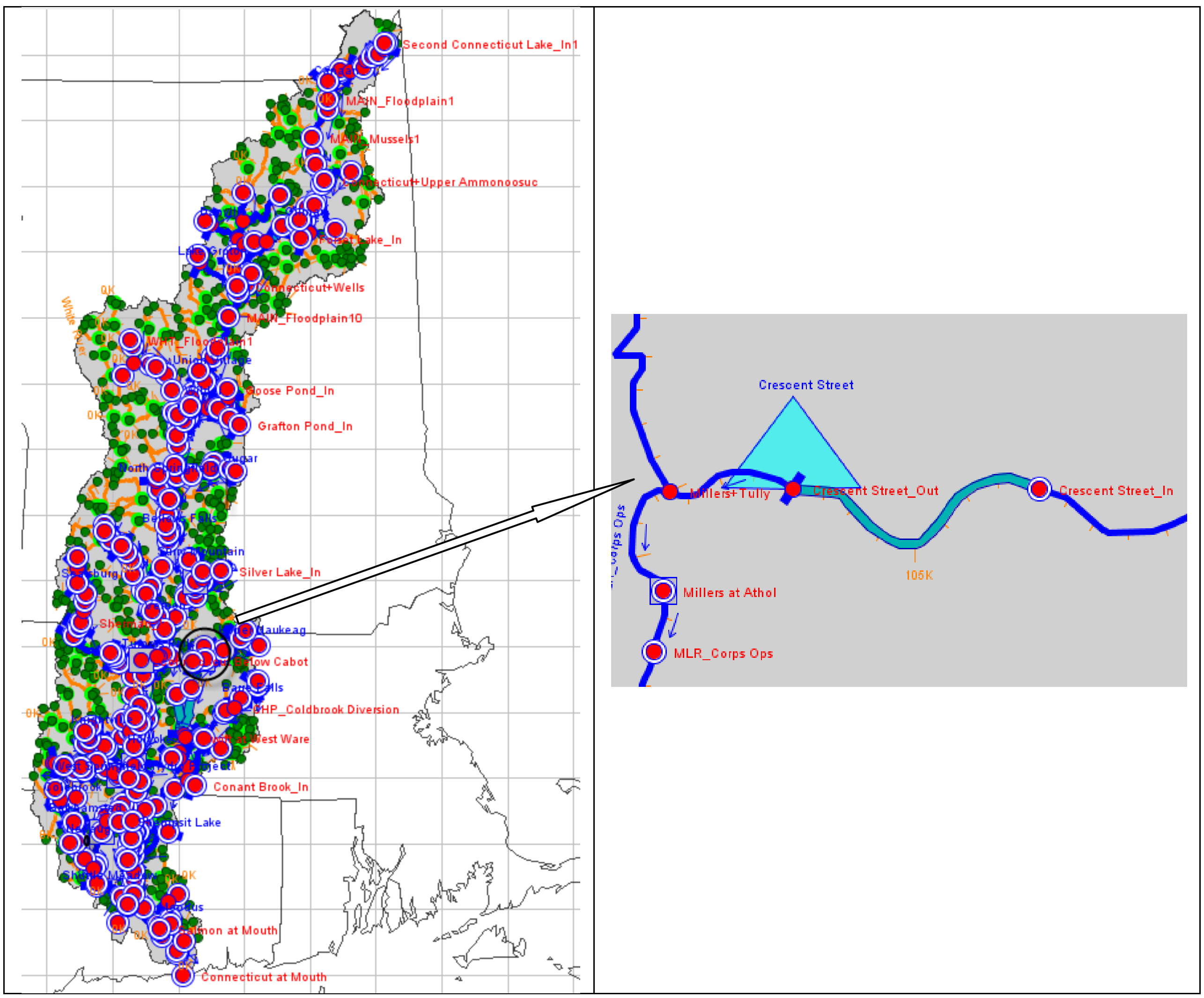


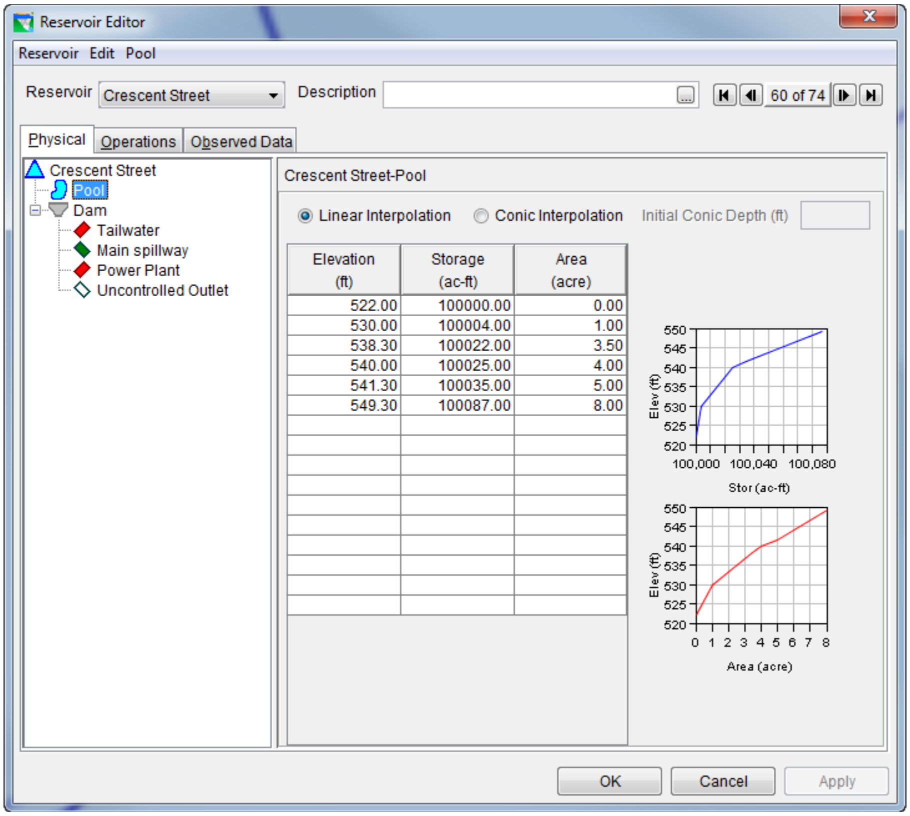
Figure 1: HEC-ResSim Map Display Showing Location of Crescent Street Dam

Figure 2: Photo of Crescent Street Dam

II. Physical Characteristics

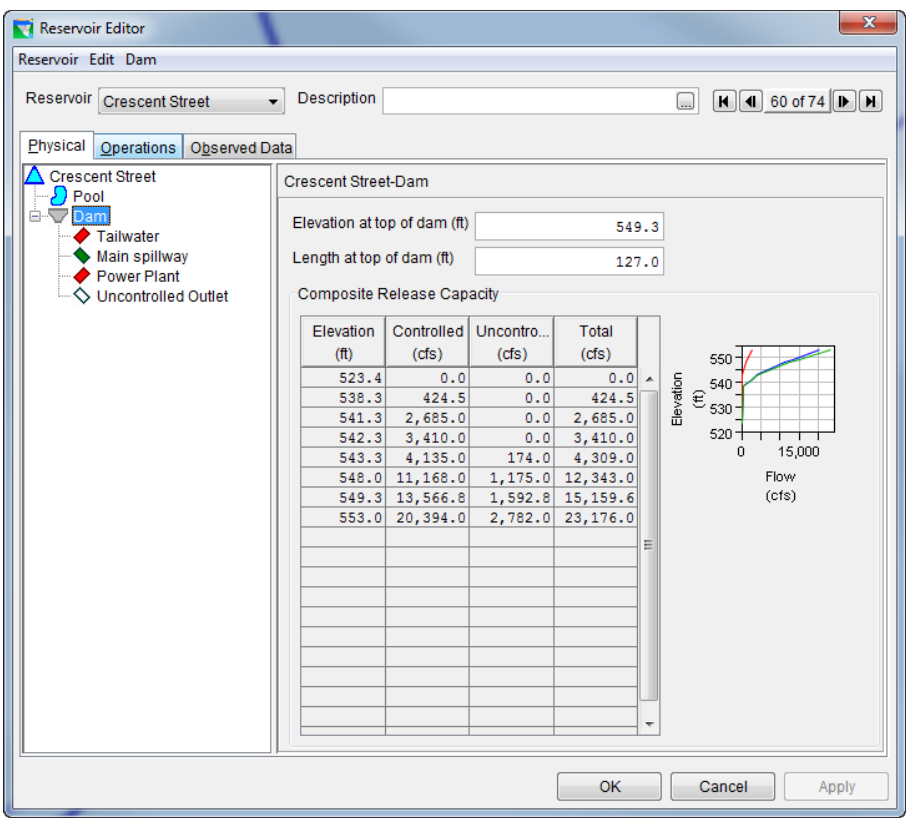
The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[23]. The dam consists of three types of outlets: (1) an uncontrolled Main spillway, (2) an uncontrolled outlet, and (3) a power plant as shown in Figure 4. The power plant has a maximum capacity of 510 cfs. The dam has a constant tailwater elevation of 523.4 feet.

[23] National Dam Inspection Program. Phase I Inspection Report. 1972.



Elevation (ft)	Storage (ac-ft)	Area (acre)
522.00	100000.00	0.00
530.00	100004.00	1.00
538.30	100022.00	3.50
540.00	100025.00	4.00
541.30	100035.00	5.00
549.30	100087.00	8.00

Figure 3: Reservoir Editor -- Physical Tab -- Pool



Elevation (ft)	Controlled (cfs)	Uncontro... (cfs)	Total (cfs)
523.4	0.0	0.0	0.0
538.3	424.5	0.0	424.5
541.3	2,685.0	0.0	2,685.0
542.3	3,410.0	0.0	3,410.0
543.3	4,135.0	174.0	4,309.0
548.0	11,168.0	1,175.0	12,343.0
549.3	13,566.8	1,592.8	15,159.6
553.0	20,394.0	2,782.0	23,176.0

Figure 4: Reservoir Editor -- Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Crescent Street Dam's "Guide Curve" operational zones, which consist of the zones Top of Dam (549 ft), Flood Control (542.3 ft), Conservation (538.3 ft), and Inactive (523.4 ft)[1].

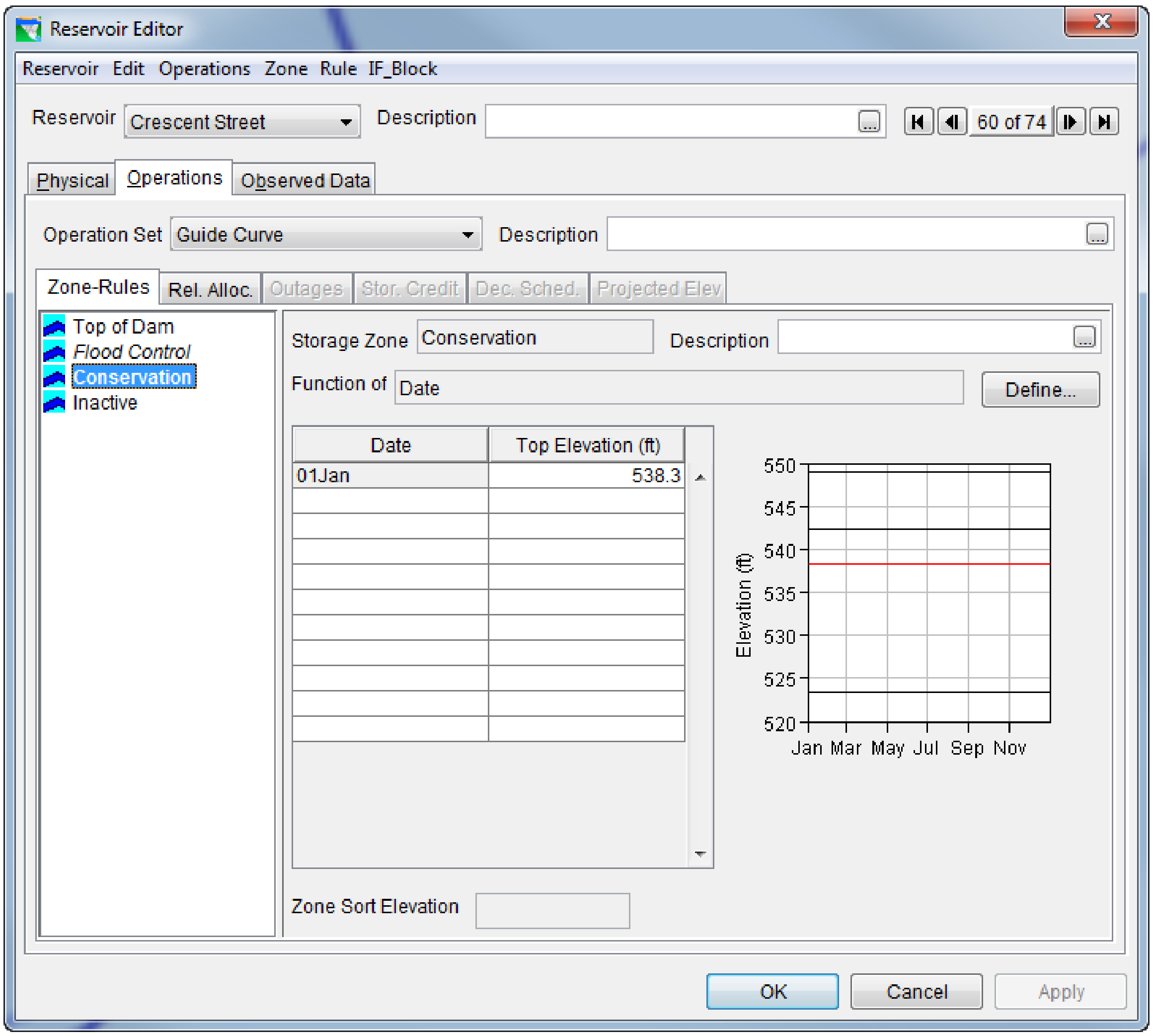


Figure 5: Reservoir Editor -- Operations Tab – Guide Curve OpSet

B. Rule Illustrations

The operation set for Crescent Street Dam has no operating rules, making it a through flow reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity

Crystal Lake

I. Overview

Crystal Lake dam is located in the town of Enfield, NH and flows into the Mascoma River. The dam is maintained and operated by the State of New Hampshire Water Resources Board and is used primarily to provide a recreational lake with some flood control benefits.

Figure 1 shows the location of Crystal Lake as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Crystal Lake.

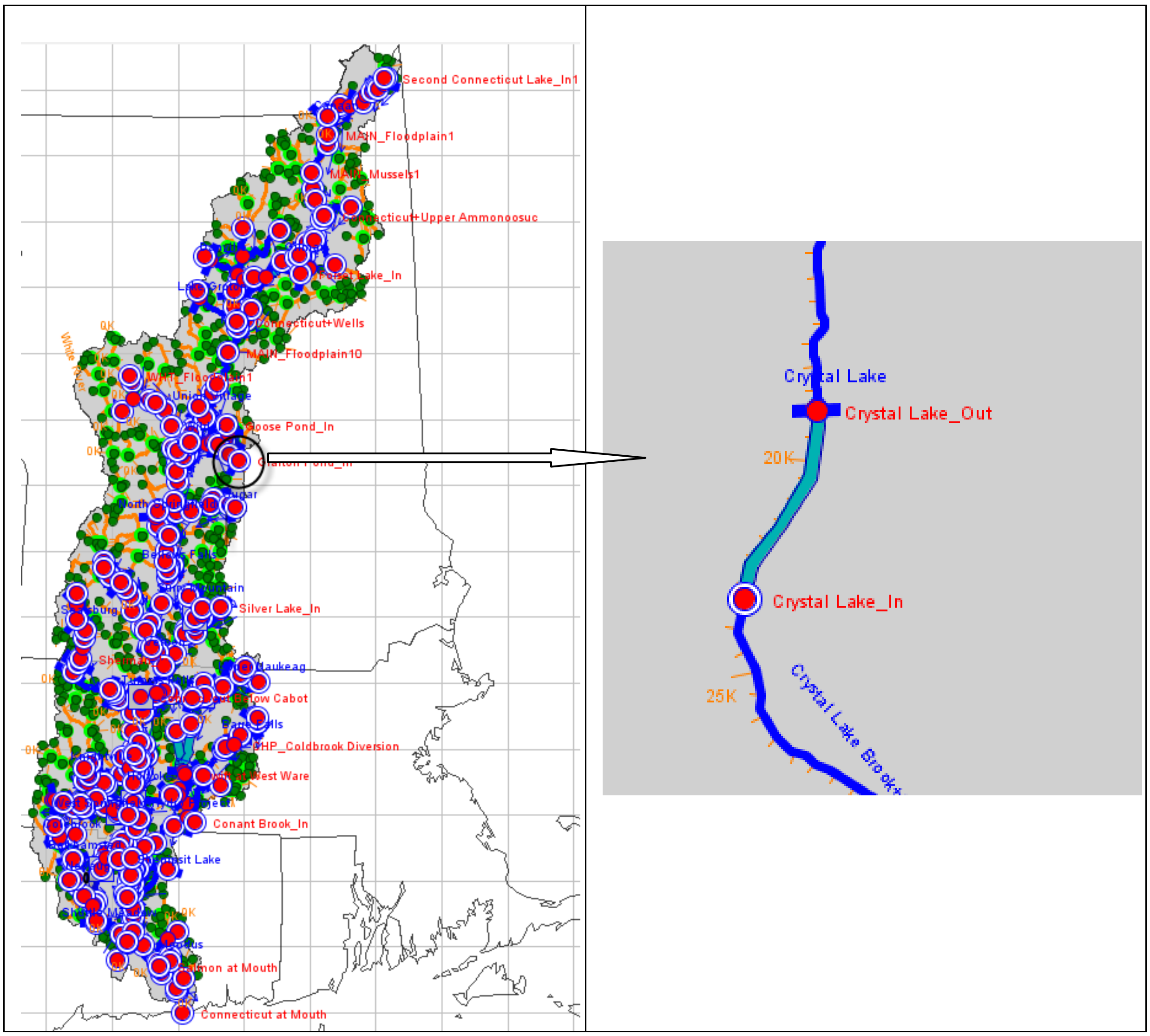


Figure 1: HEC-ResSim Map Display Showing Location of Crystal Lake

Figure 2: Photo of Crystal Lake

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[24]. The dam consists of two types of outlets: (1) uncontrolled stoplogs, (2) uncontrolled spillway as shown in Figure 4[25].

[24]NHSDam Data Sheet. Crystal Lake. 2006.
[25] National Dam Inspection Program. Phase I Inspection Report: Crystal Lake Dam. 1978

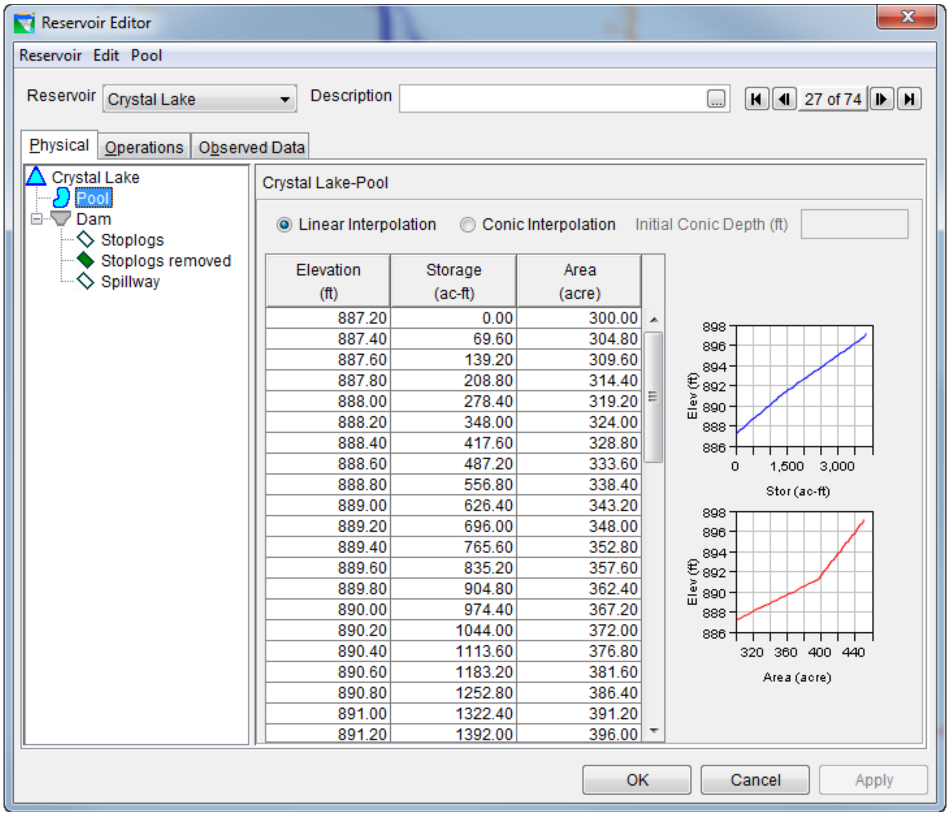


Figure 3: Reservoir Editor -- Physical Tab -- Pool

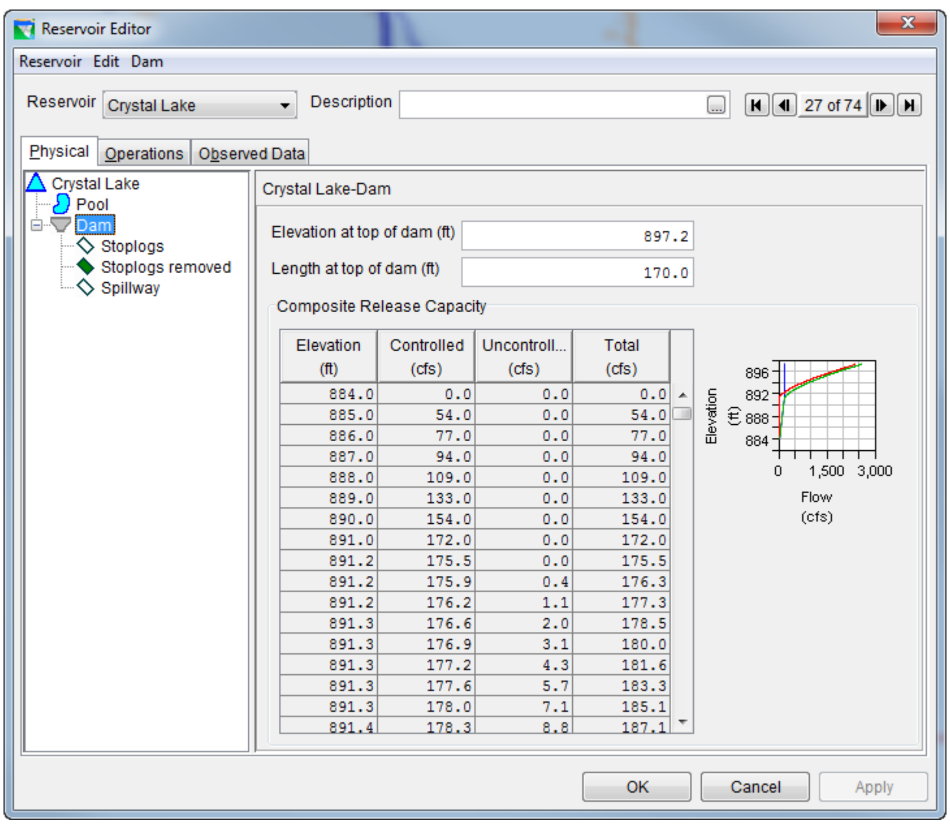


Figure 4: Reservoir Editor -- Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 4 shows the definition of Crystal Lake's "ExistingOps" operational zones, which consist of the zones Flood Control (897.2 ft), Conservation (887.8-891.8 ft), and Inactive (880.5 ft)[1].

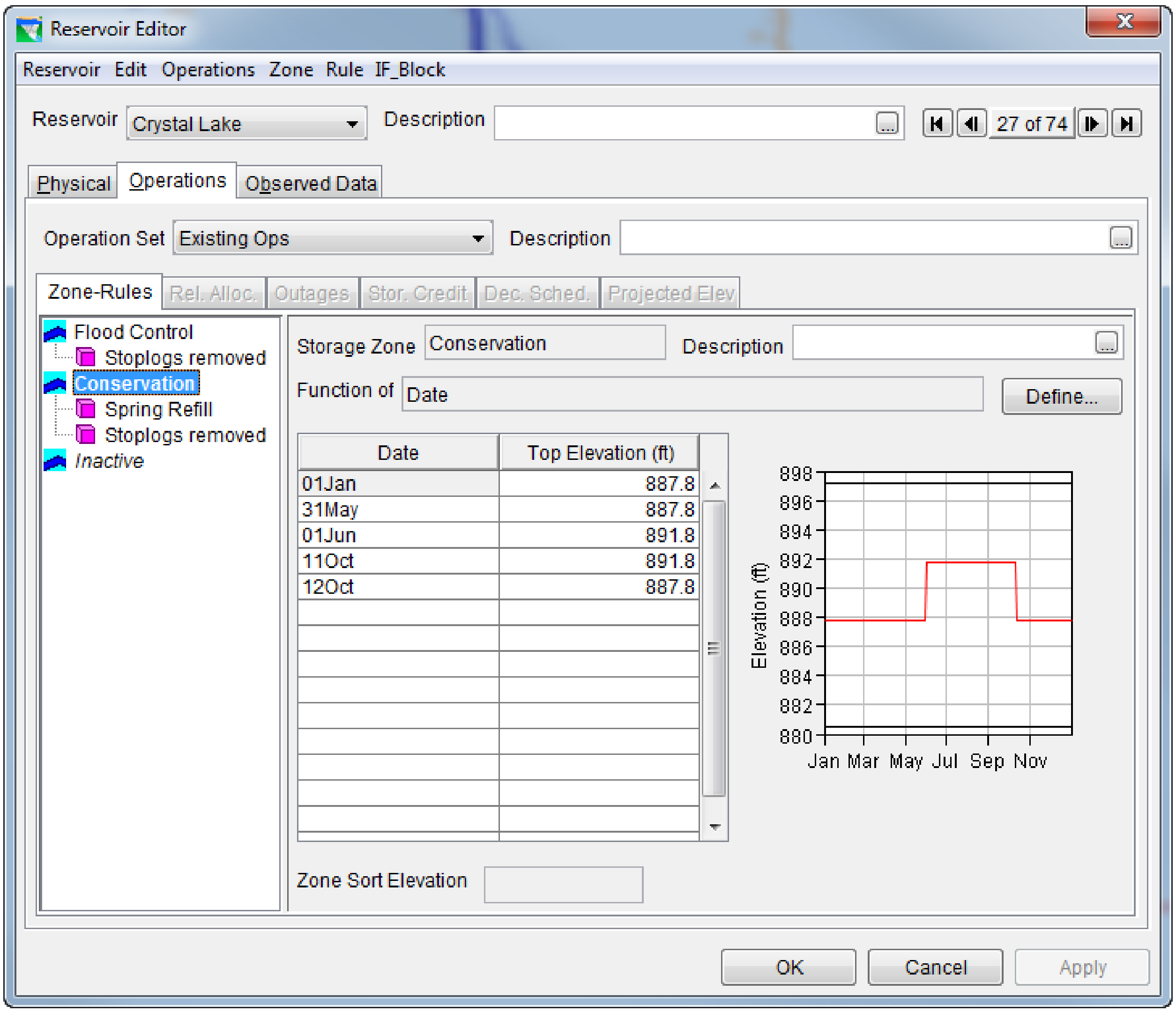


Figure 5: Reservoir Editor -- Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 5 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

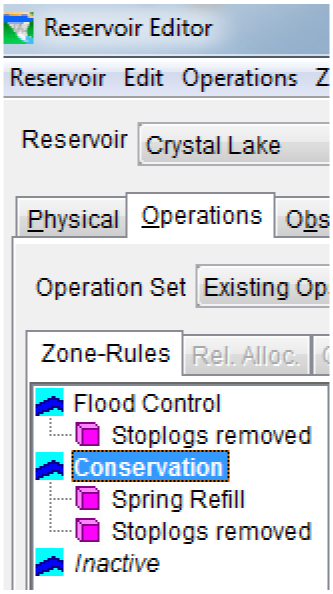


Figure 5: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Stoplogs removed

Figure 6 shows the content of “Stoplogs removed” rule. This rule defines the maximum release from a controlled gate when stoplogs are removed as a function of pool elevation.

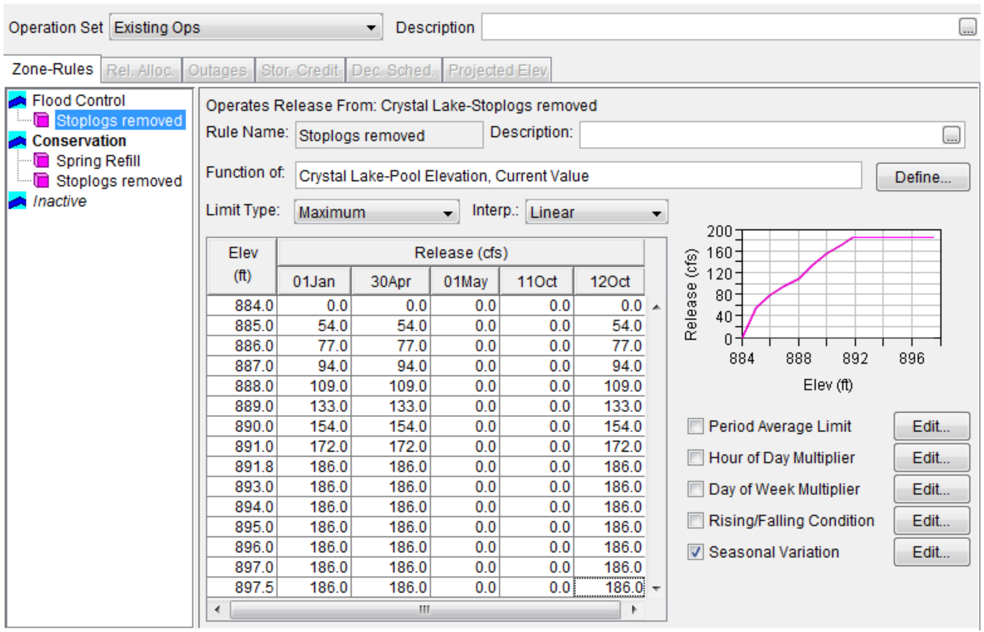


Figure 6: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Stoplogs removed

2. Spring Refill

Figure 7 shows the content of “Spring Refill” rule. This rule defines the maximum seasonal release as a function of Inflow.

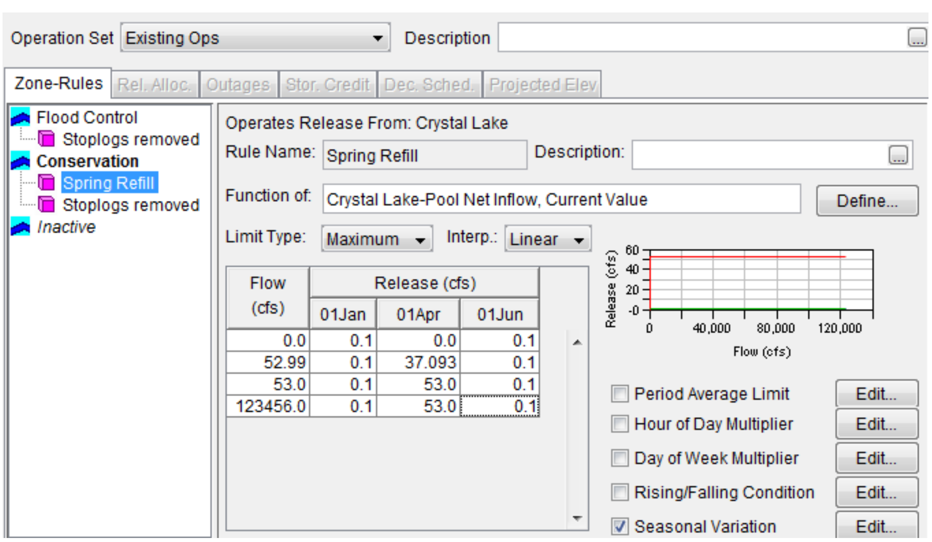


Figure 7 Reservoir Editor: Operations Tab – Existing Ops OpSet – Spring Refill

Danville

I. Overview

Constructed in 1916, Green Mountain Power Corporation (GMP) owns and operates the West Danville Dam and hydroelectric generating facility (Station No. 15) located on Joe's Brook in Caledonia County, Vermont. The dam itself creates Joes Pond.

Figure 1 shows the location of Danville Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Danville Dam.

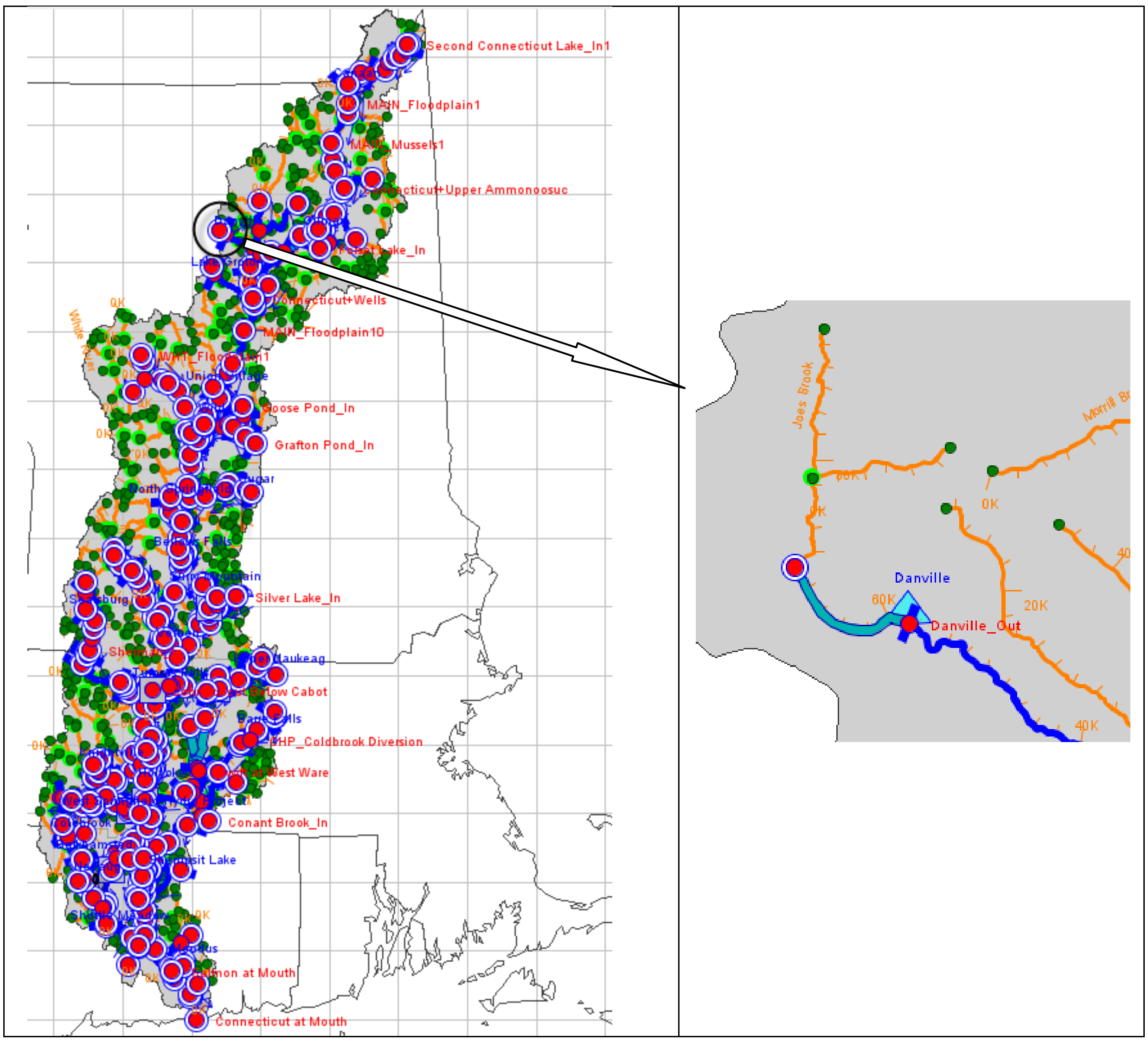


Figure 1 HEC-ResSim Map Display Showing Location of Danville

Figure 2: Photo of Joes Pond, which is impounded by the West Danville Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[26]. The dam consists of two types of outlets: (1) controlled sluice gate, and (2) power plant as shown in Figure 4[1,27].

[26] National Inventory of Dams database
[27] Green Mountain Power Corporation. Operating Plan for the West Danville Project. 2005.

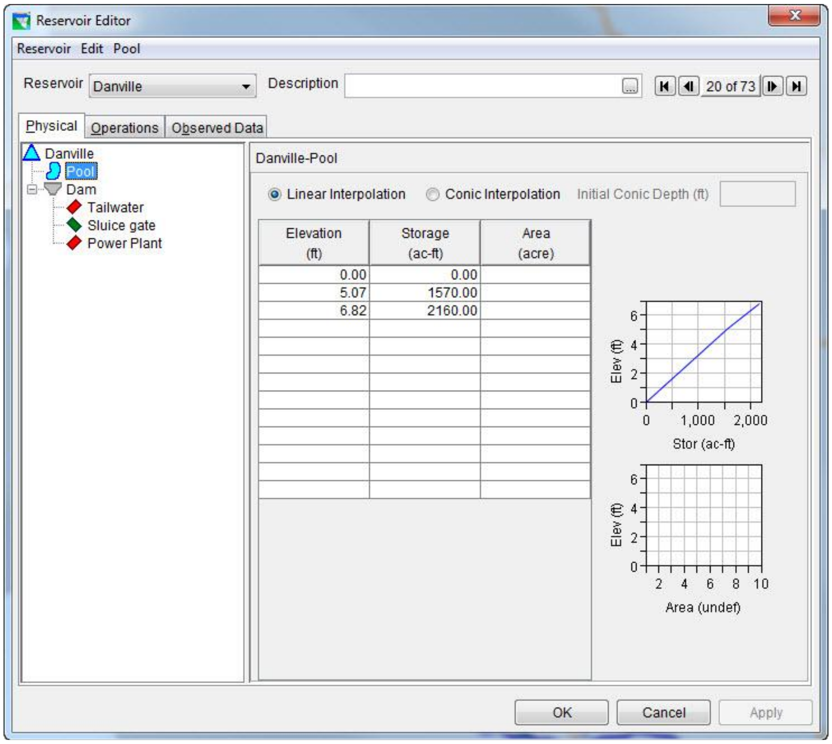


Figure 3: Reservoir Editor -- Physical Tab -- Pool

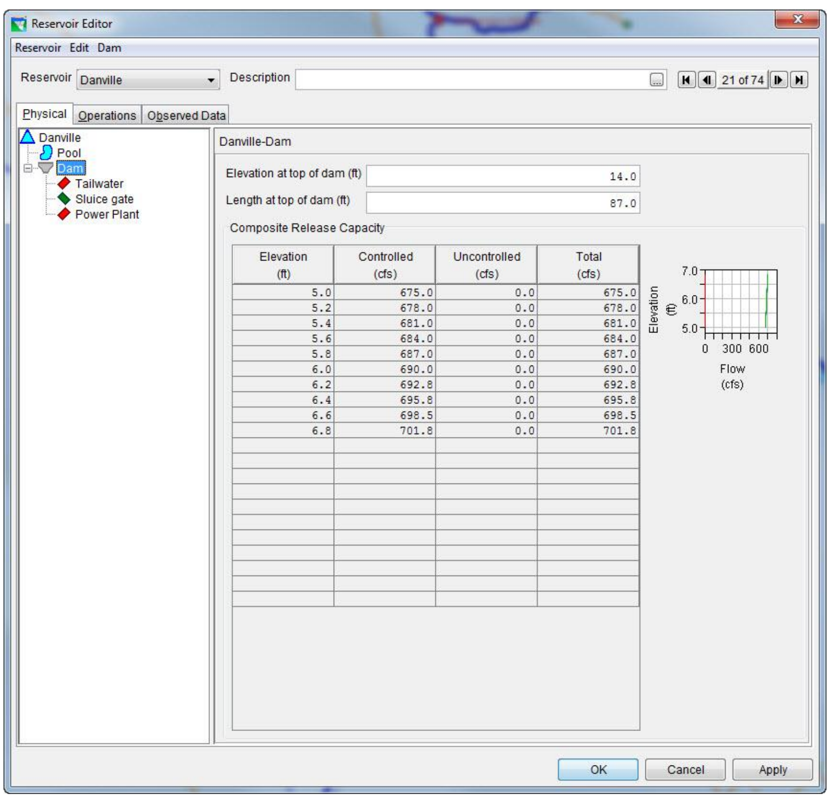


Figure 4: Reservoir Editor -- Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Danville's "Existing Ops" operational zones, which consist of the zones of Top of dam (6.82 ft), Flood Control (5.3 ft), Conservation (5.07 ft), Min Pool (5 ft), and Inactive zone (4.8 ft)[2].

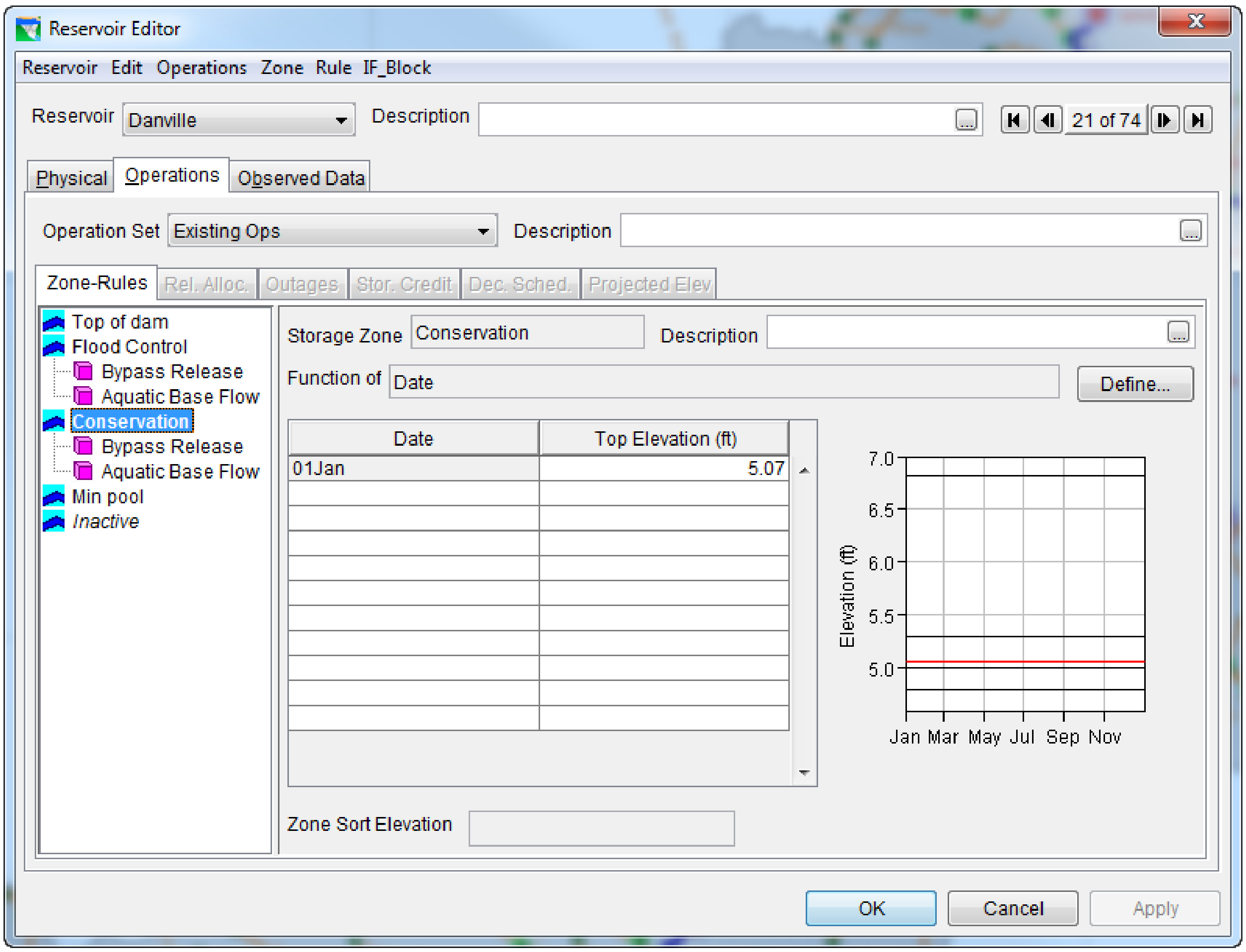


Figure 5: Reservoir Editor -- Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

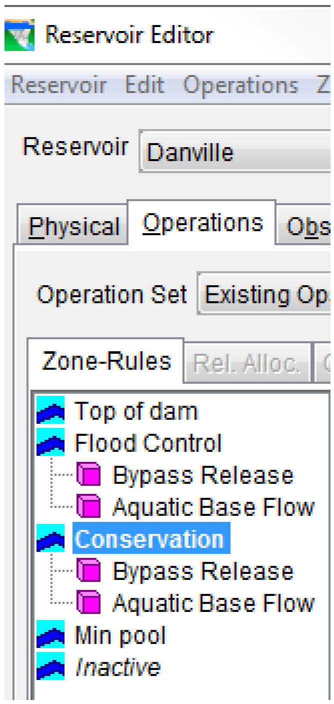


Figure 6: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Bypass Release

Figure 7 shows the content of "Bypass Release" rule. This rule represents a constant 7 cfs release through the sluice gate.

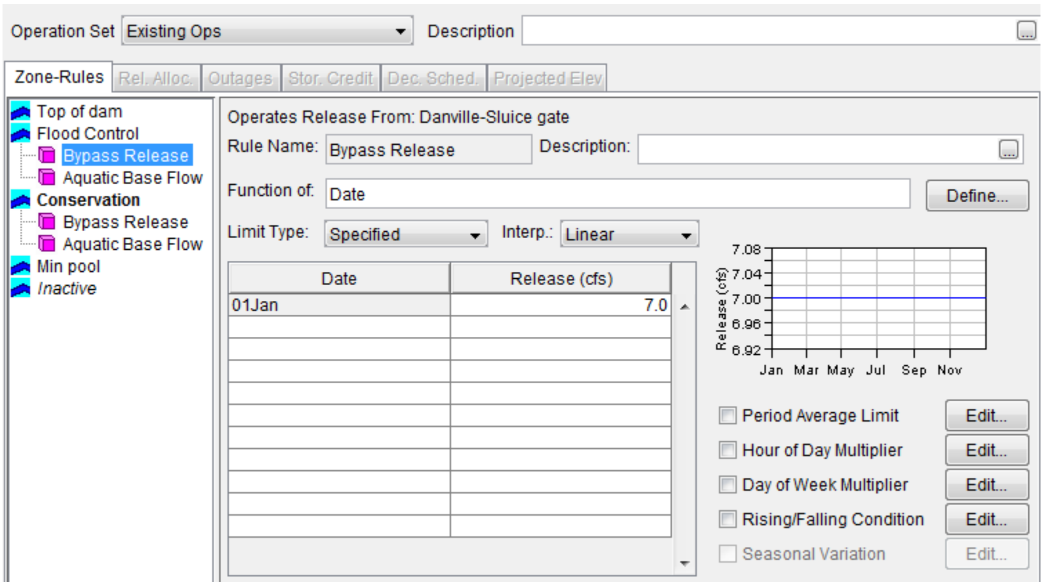


Figure 7: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Bypass Release

2. Aquatic Base Flow

Figure 8 shows the content of "Aquatic Base Flow" rule. This rule represents the minimum required to be released through power plant.

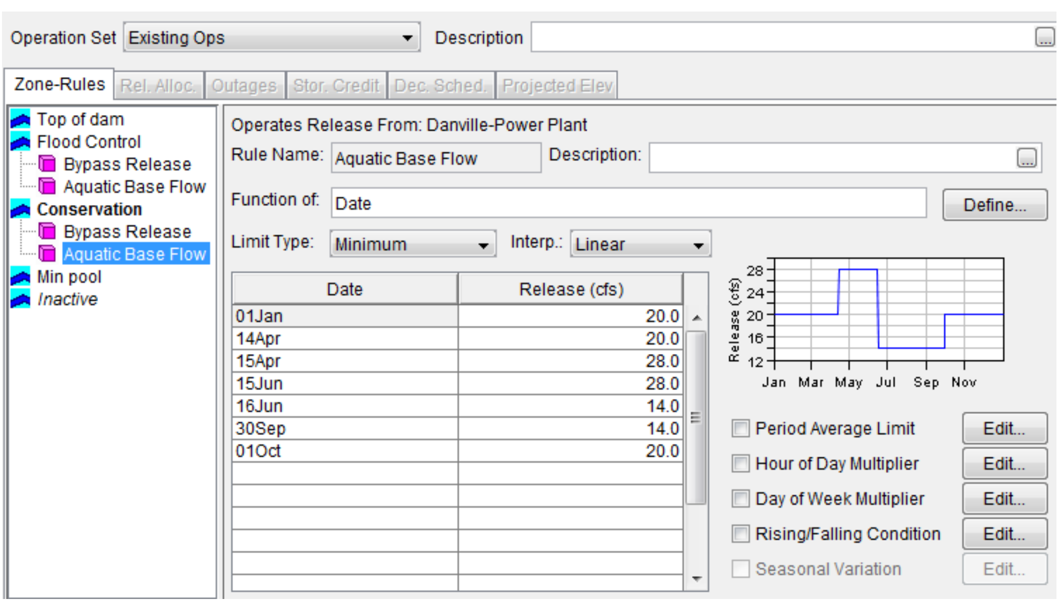


Figure 8: Reservoir Editor -- Operations Tab – Existing Ops OpSet – Aquatic Base Flow

Deerfield No. 2 Development

I. Overview

Deerfield No. 2 Development is located downstream of Shelburne Falls on the Deerfield River and is the closest counting up from confluence with the Connecticut River. It is owned and operated by TransCanada Hydro Northeast Inc. for hydropower generation on a run-of-river basis.

Figure 1 shows the location of Deerfield No. 2 dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from Deerfield No.2 dam.

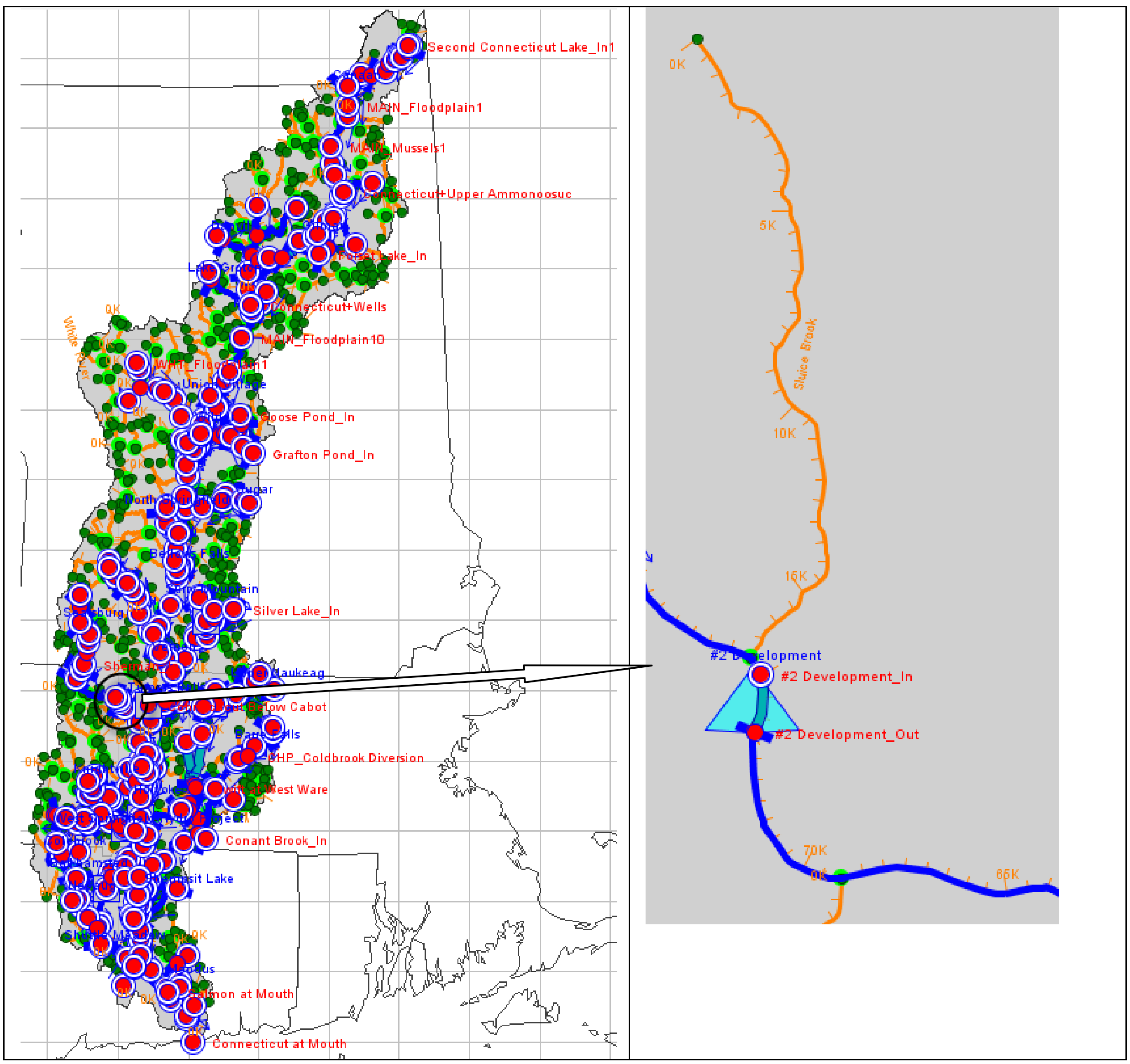


Figure 1: HEC-ResSim Map Display Showing Location of Deerfield No.2

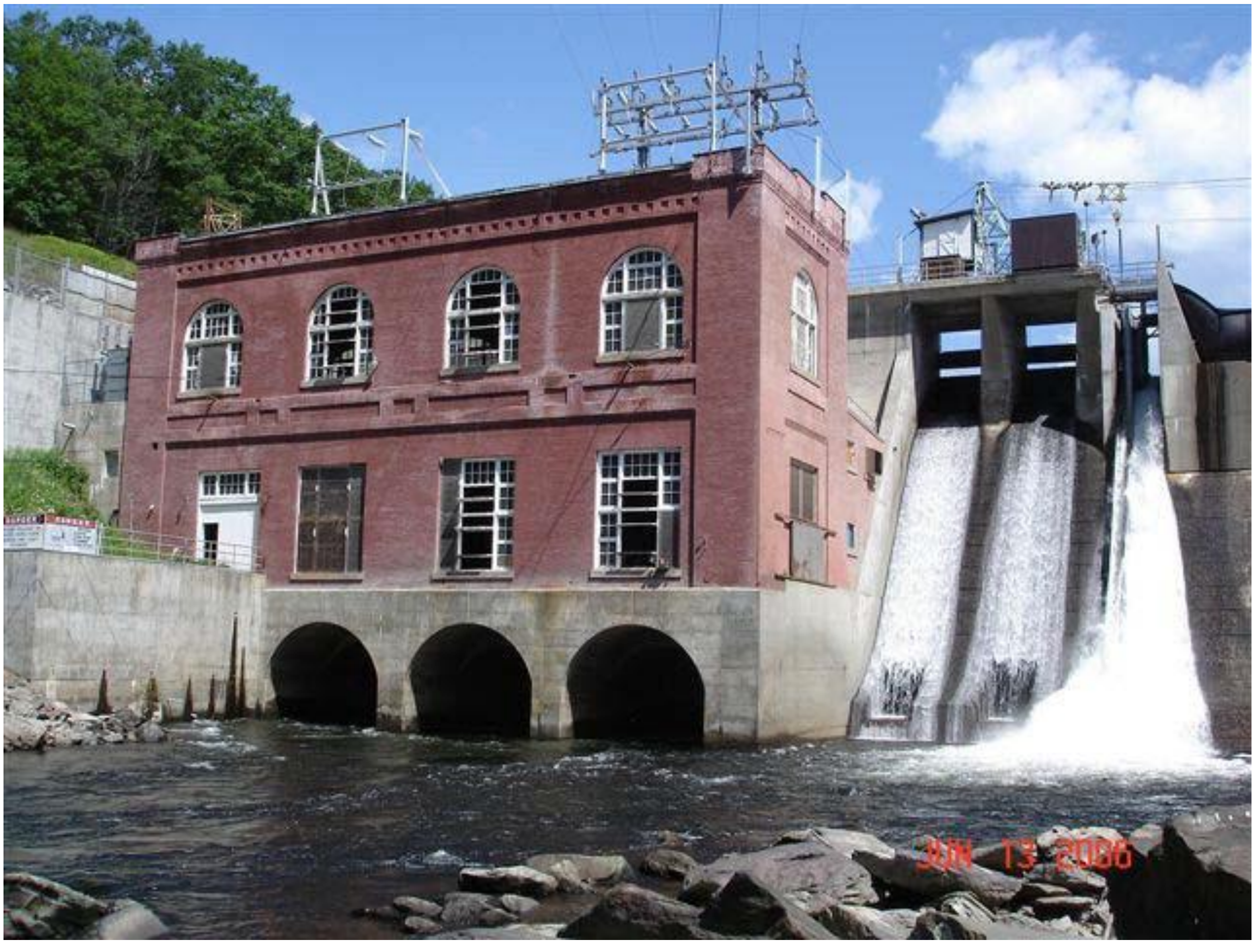


Figure 2: Photo of Deerfield No. 2 Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[28]. The dam consists of three types of outlets: (1) controlled spillway, (2) controlled sluice, and power plant as shown in Figure 4 (TransCanada Corporation).

[28] Data provided by TransCanada

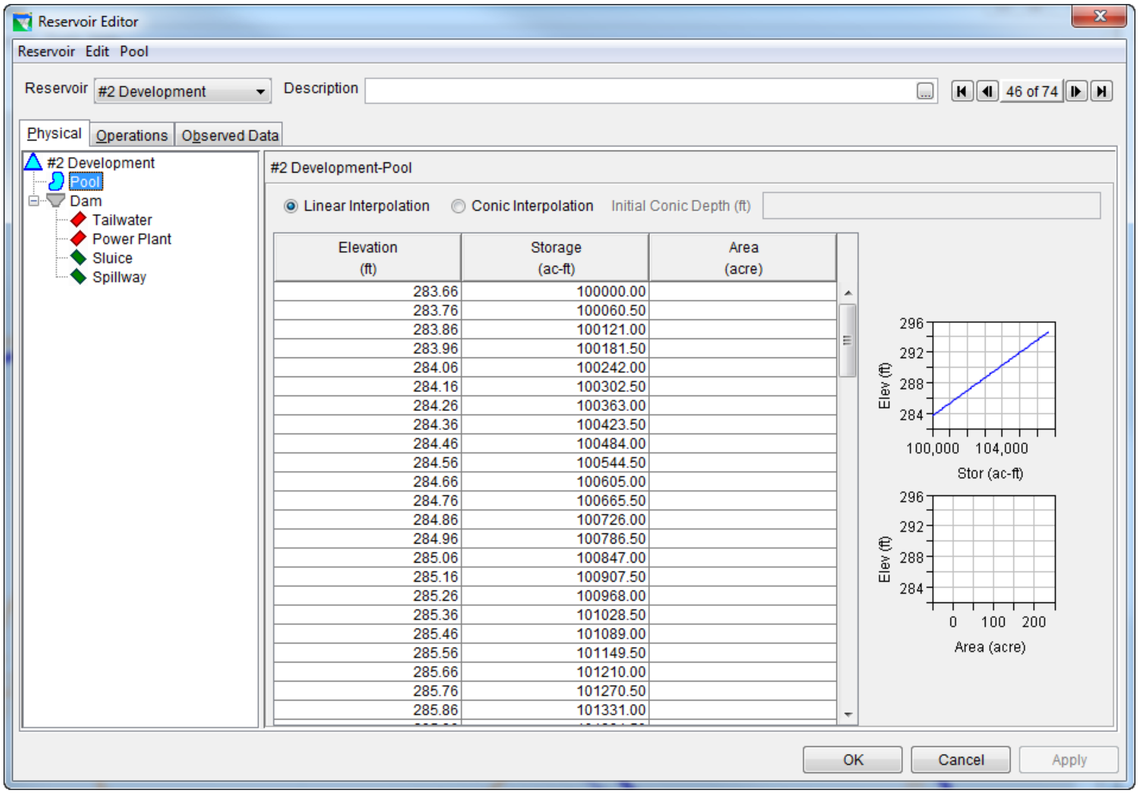


Figure 3: Reservoir Editor: Physical Tab -- Pool

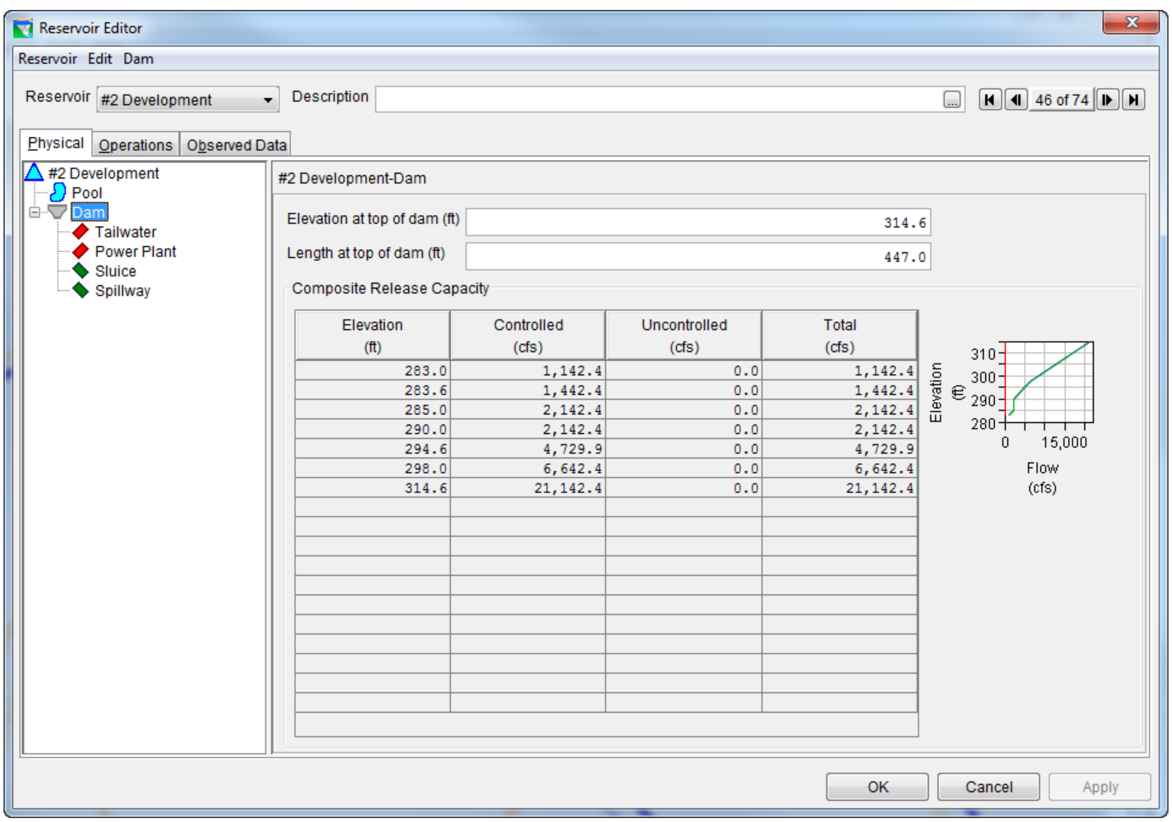


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Deerfield No. 2's "ExistingOps" operational zones, which consist of zones of Top of dam (314.6 ft), Conservation (294.6 ft), Min Pool (283.6 ft), and Inactive zone (283 ft)[1].

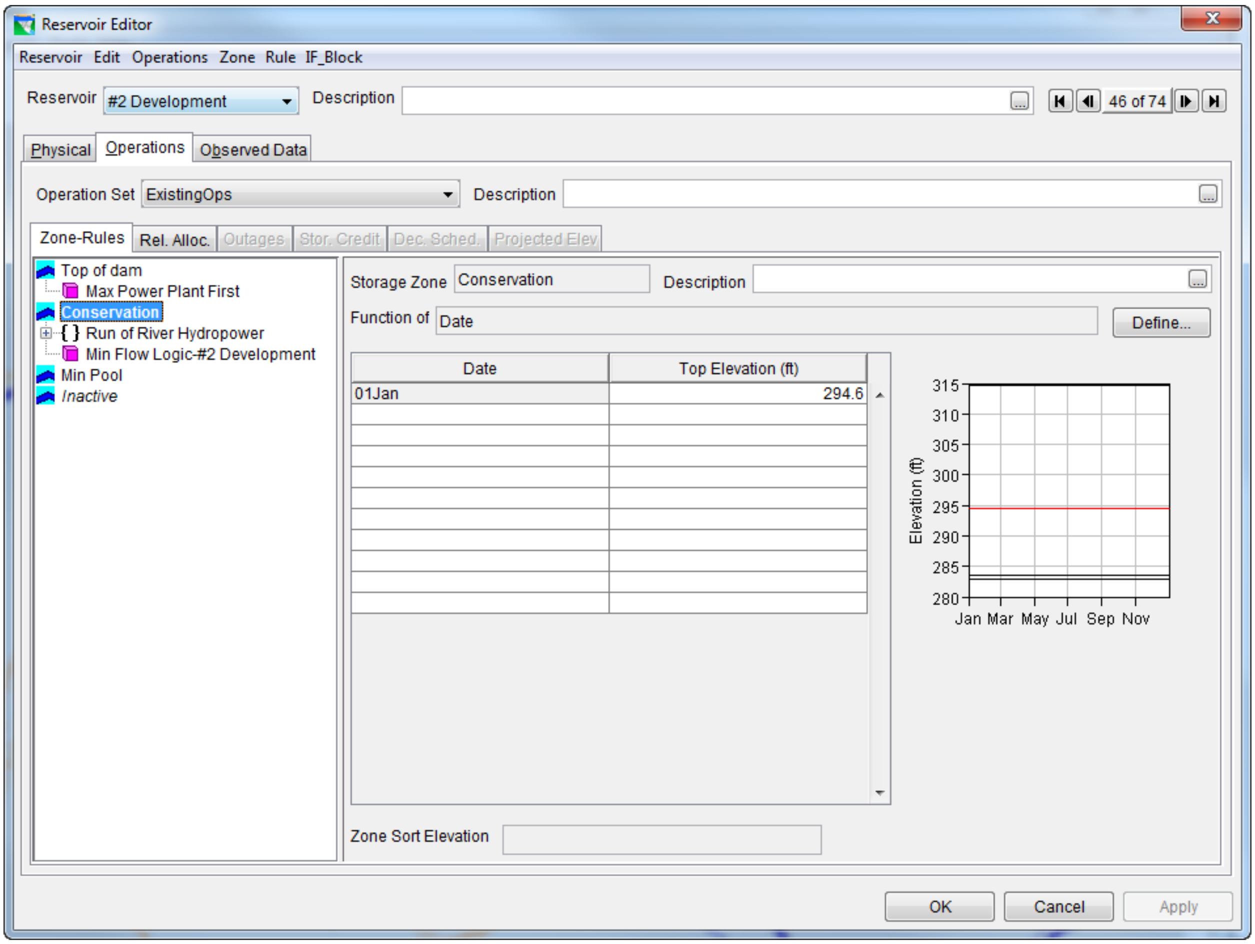


Figure 5 Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Buford Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The spillway gets the remainder of the release until it reaches capacity. After the capacity through the spillway is reached, the remainder of the release goes through the sluice gate.

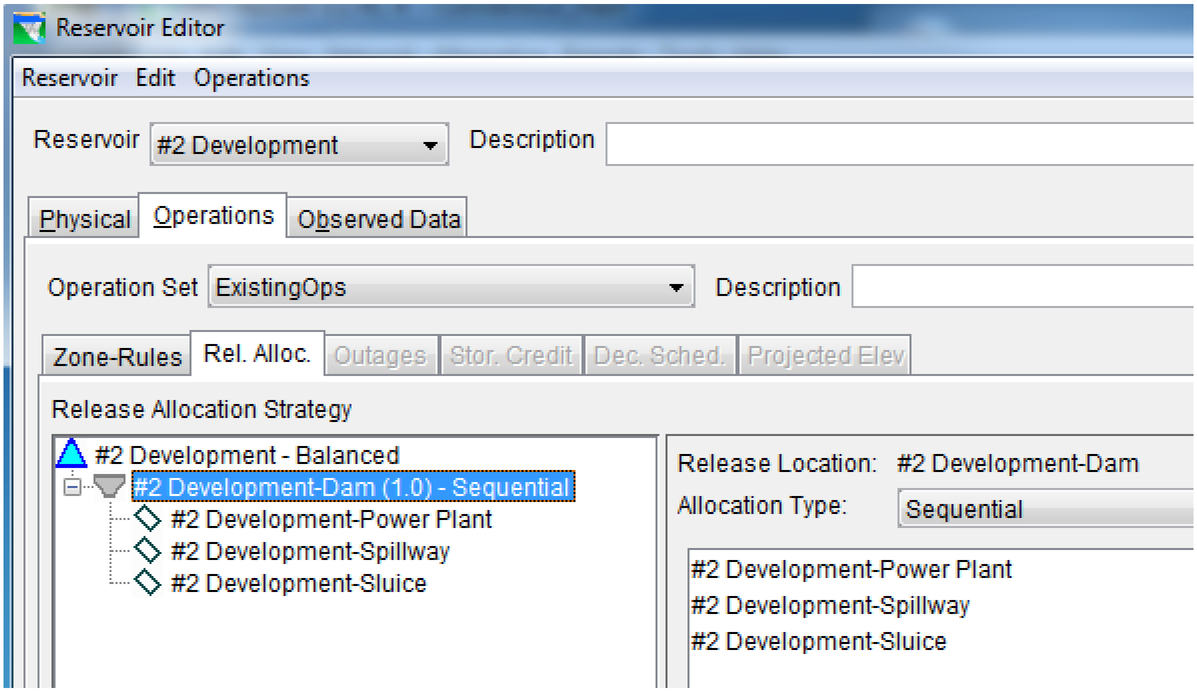


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[29].

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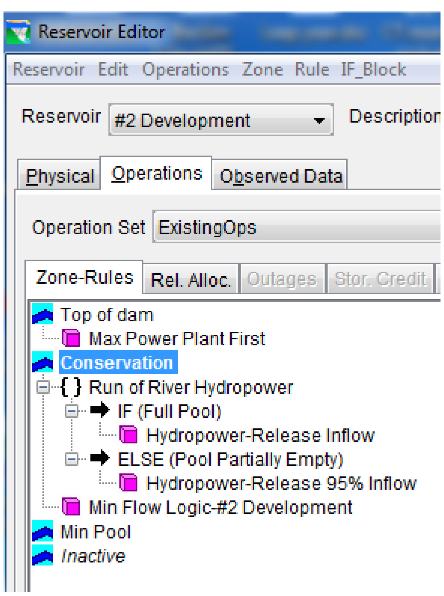


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[29] TransCanada. Deerfield River Operational Constraints. 2012.

C. Rule Descriptions

1. Max Power Plant First

Figure 8 shows the content of "Max Power Plant First" rule. This rule forces the inflow to pass through the power plant first until it reaches the maximum plant capacity.

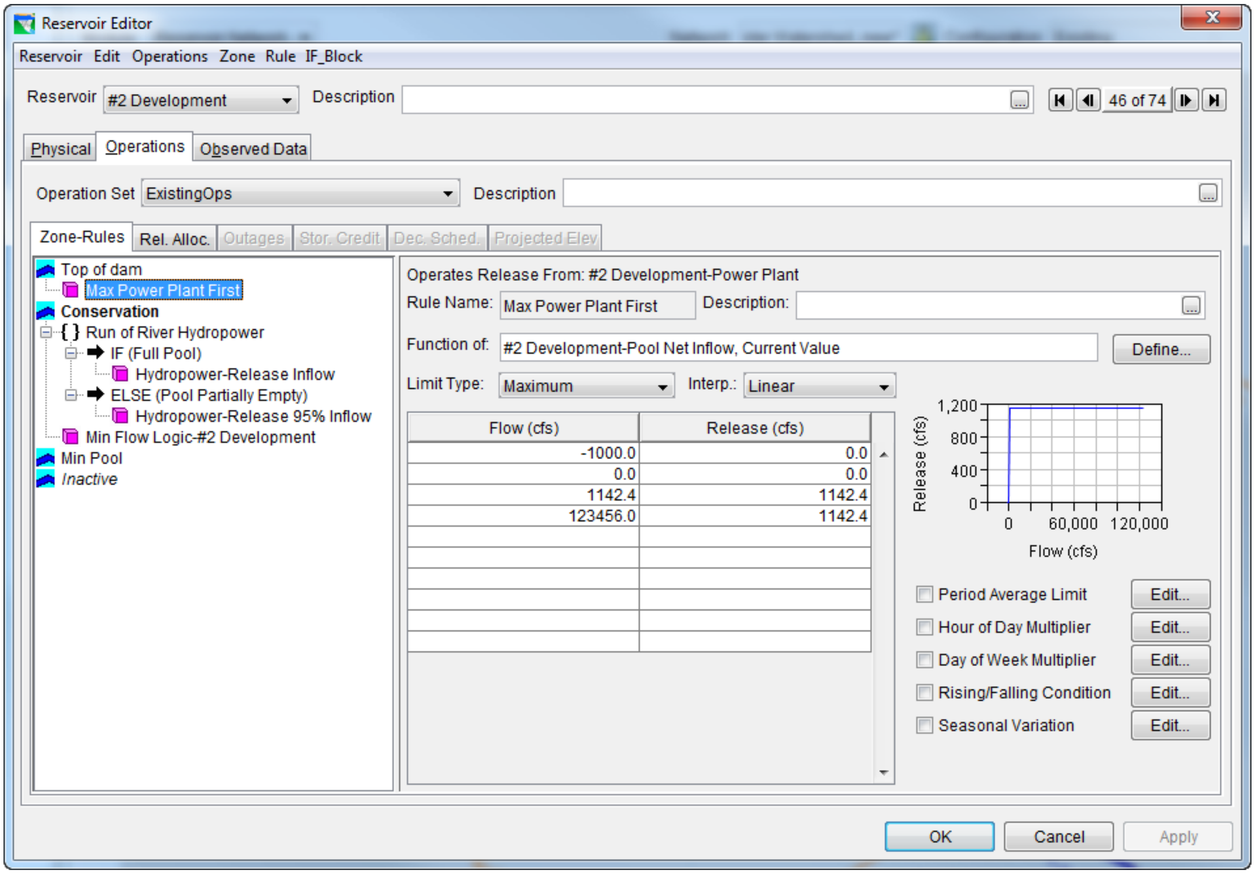
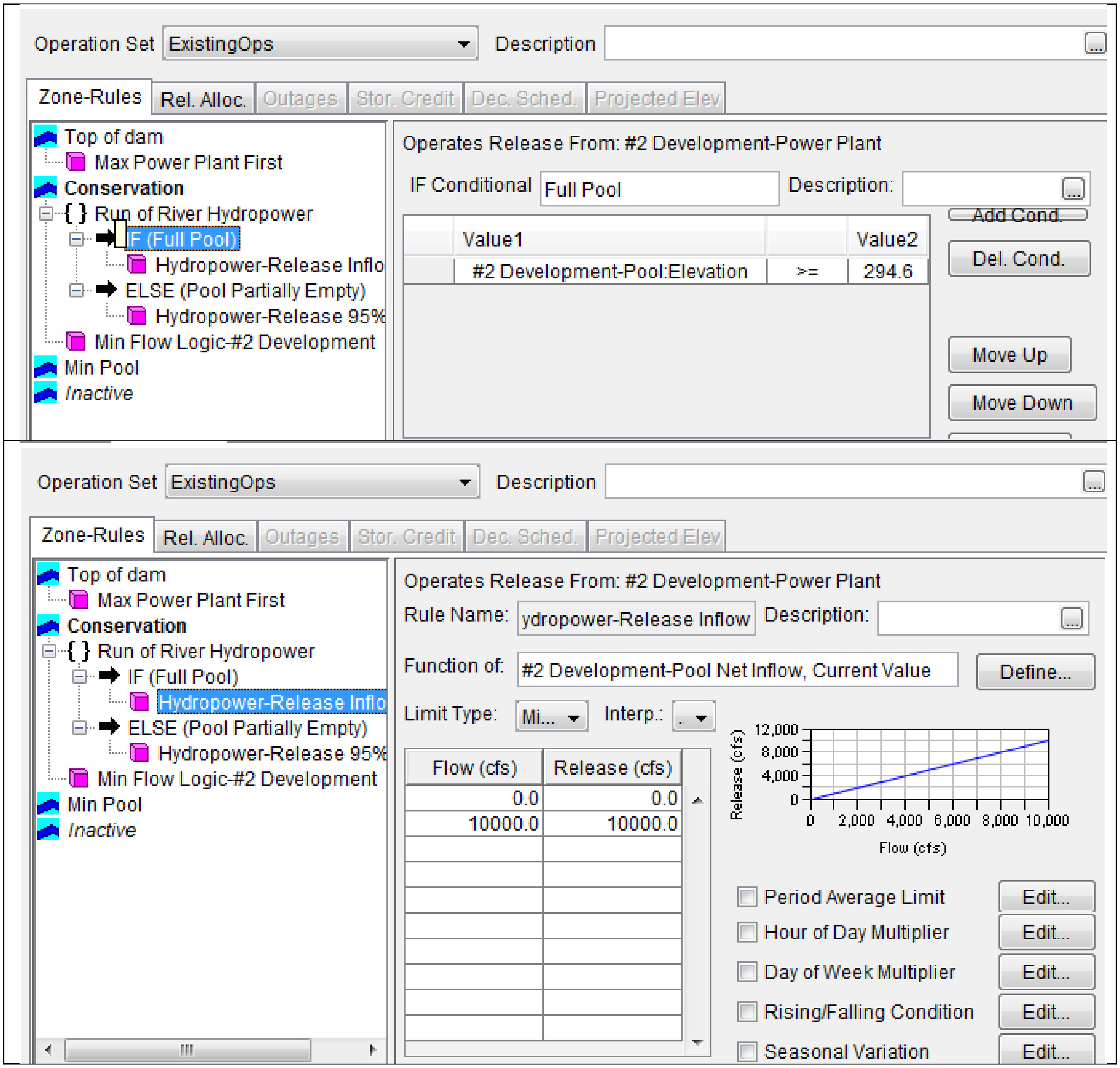


Figure 8 Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Power Plant First

2. *Run of River Hydropower*

Figure 9 shows the content of "Run of River Hydropower" rule. This rule release total inflow through power plant when pool elevation is higher than conservation elevation and 95% of inflow when pool elevation is less than conservation zone as per the run-of-river modeling strategy.



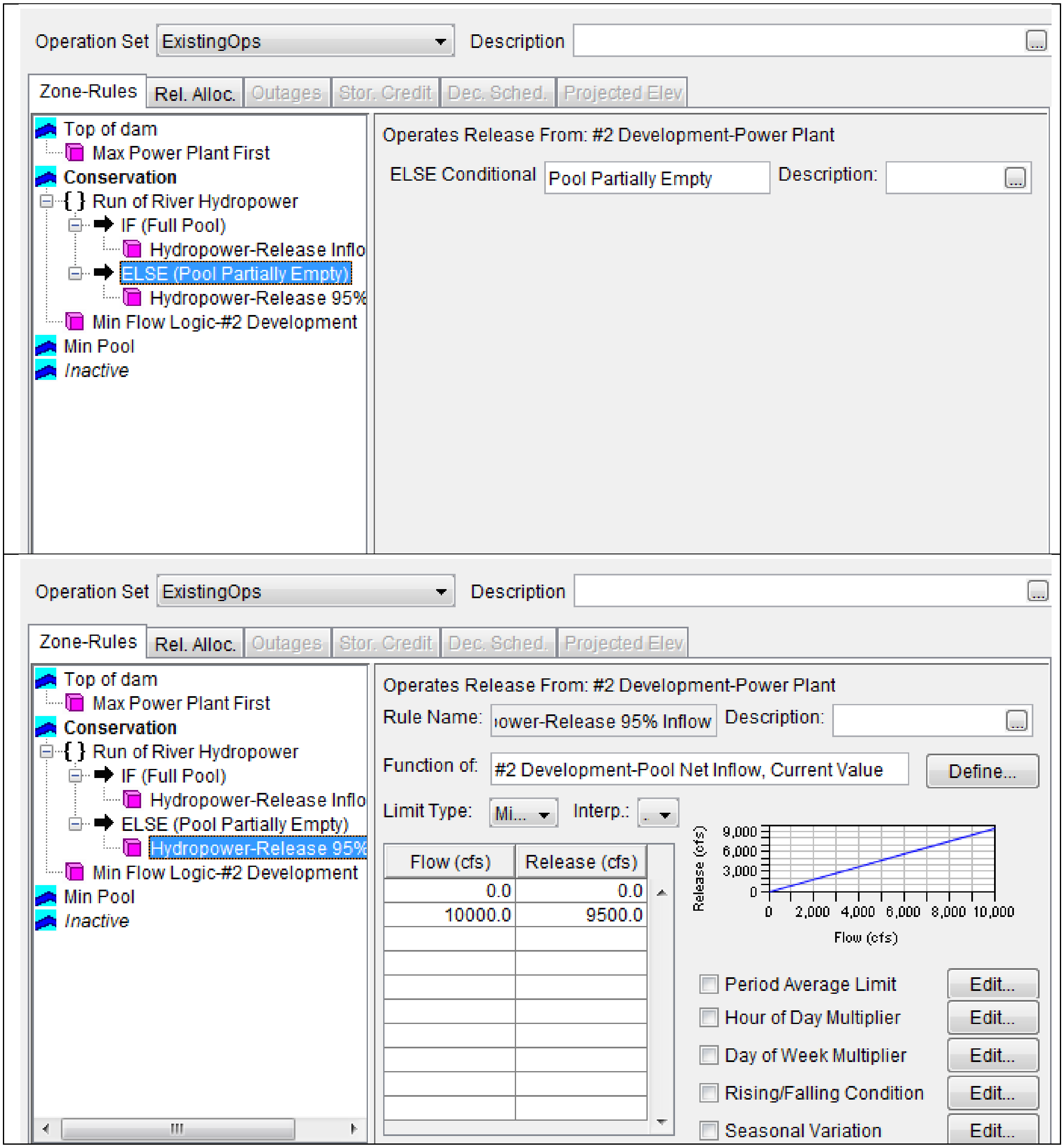


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Run of River hydropower

3. *Min Flow Logic#2 Development*

Figure 10 shows the content of Min Flow Log#2 Development. This rule represents the minimum flow of 200 cfs from Deerfield #2.

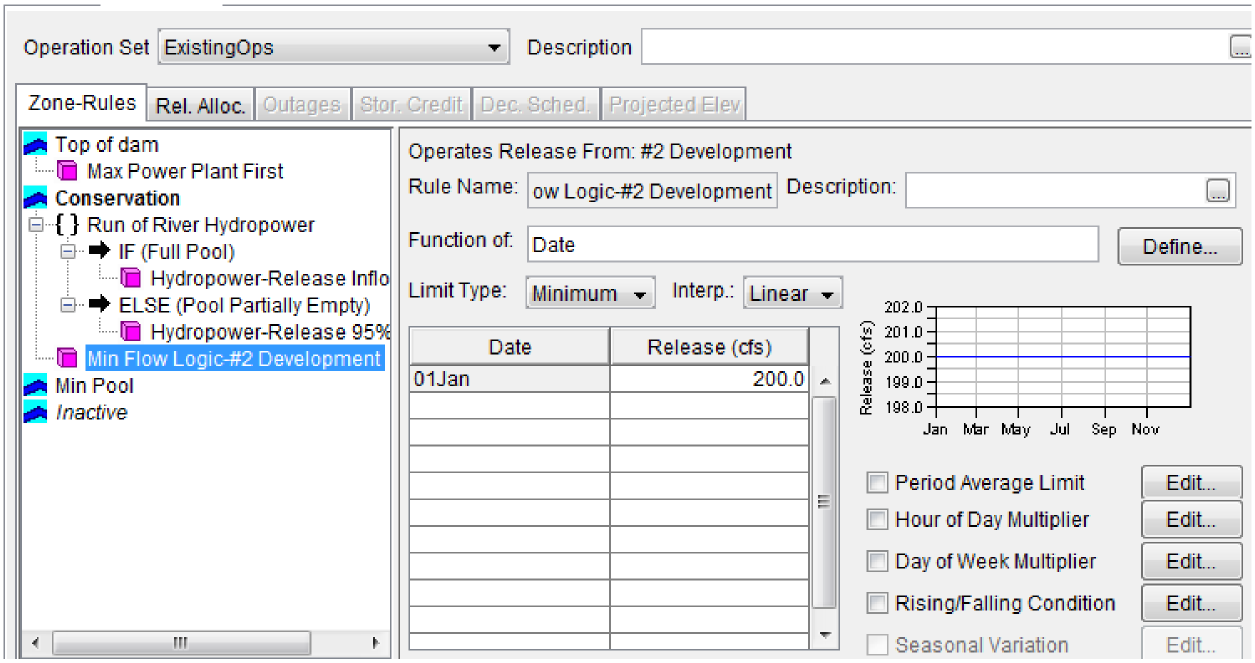


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic #2 Development

Deerfield No. 3 Development

I. Overview

Deerfield No. 3 Development is located on the Deerfield River upstream from Selburne Falls, MA. It is owned and operated by TransCanada Hydro Northeast Inc for hydropower generation on a run-of-river basis.

Figure 1 shows the location of Deerfield No. 3 dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Deerfield No. 3 dam

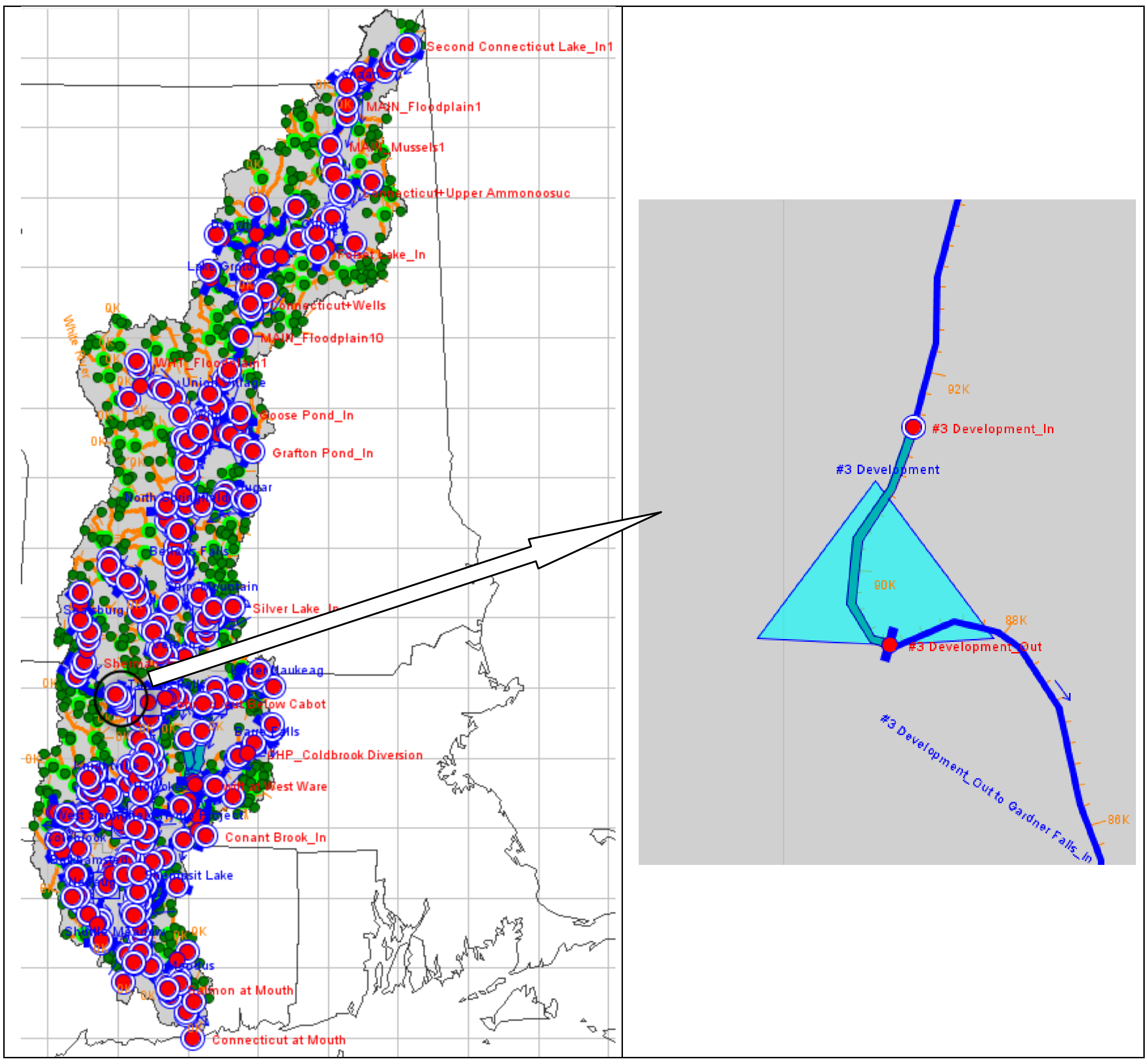


Figure 1: HEC-ResSim Map Display Showing Location of Deerfield No. 3

Figure 2: Photo of Deerfield No. 3 Development

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[30]. The dam consists of four types of outlets: (1) controlled sluice, (2) controlled old fish gate, (3) uncontrolled flashboard spillway, and (4) power plant as shown in Figure 4.

[30] Data provided by TransCanada

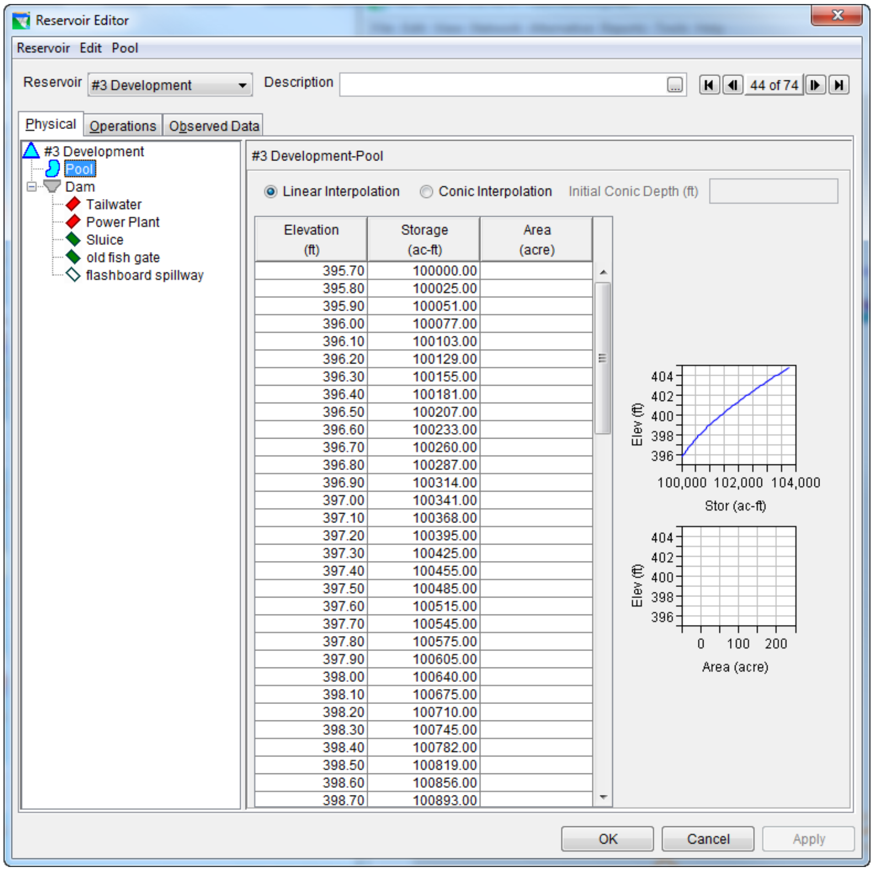


Figure 3: Reservoir Editor: Physical Tab -- Pool

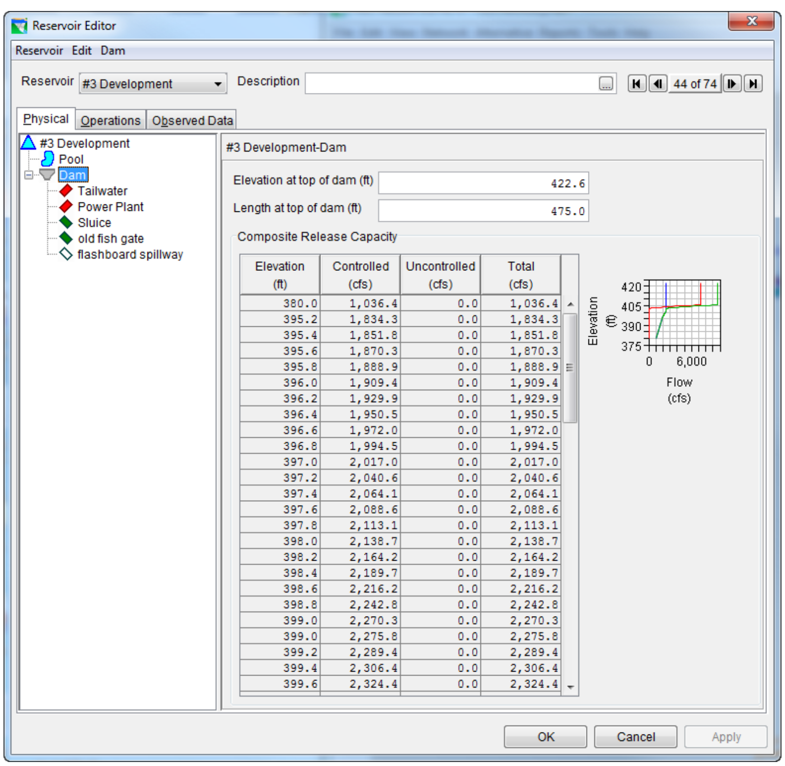


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Deerfield No. 3's "ExistingOps" operational zones, which consist of zones of Top of dam (422.6 ft), conservation (402.6 ft), Min Pool (399.6 ft), and Inactive zone (370 ft)[1].

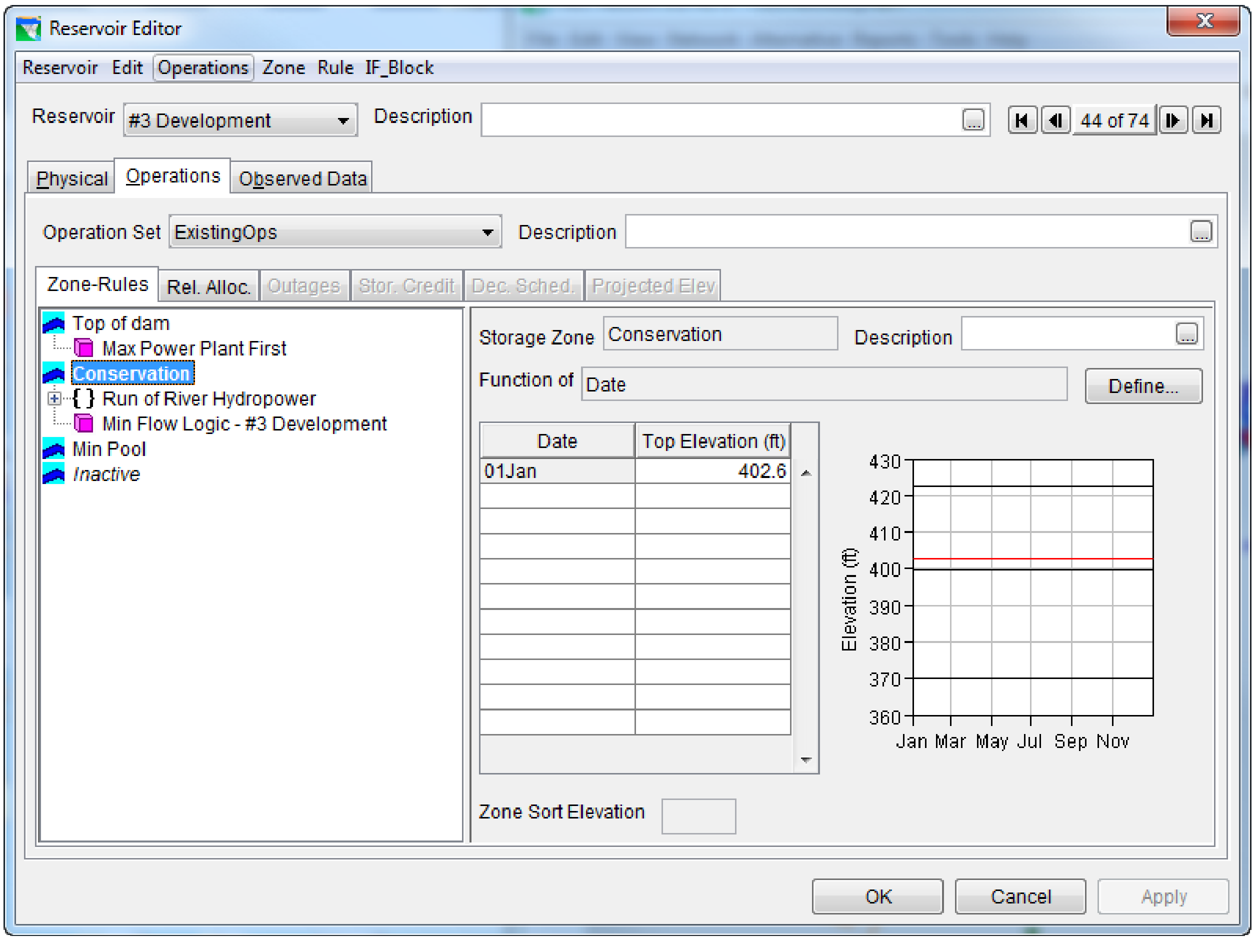


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Buford Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The sluice gate the remainder of the release until it reaches capacity. After the capacity through the sluice is reached, the remainder of the release goes through the old fish gate.

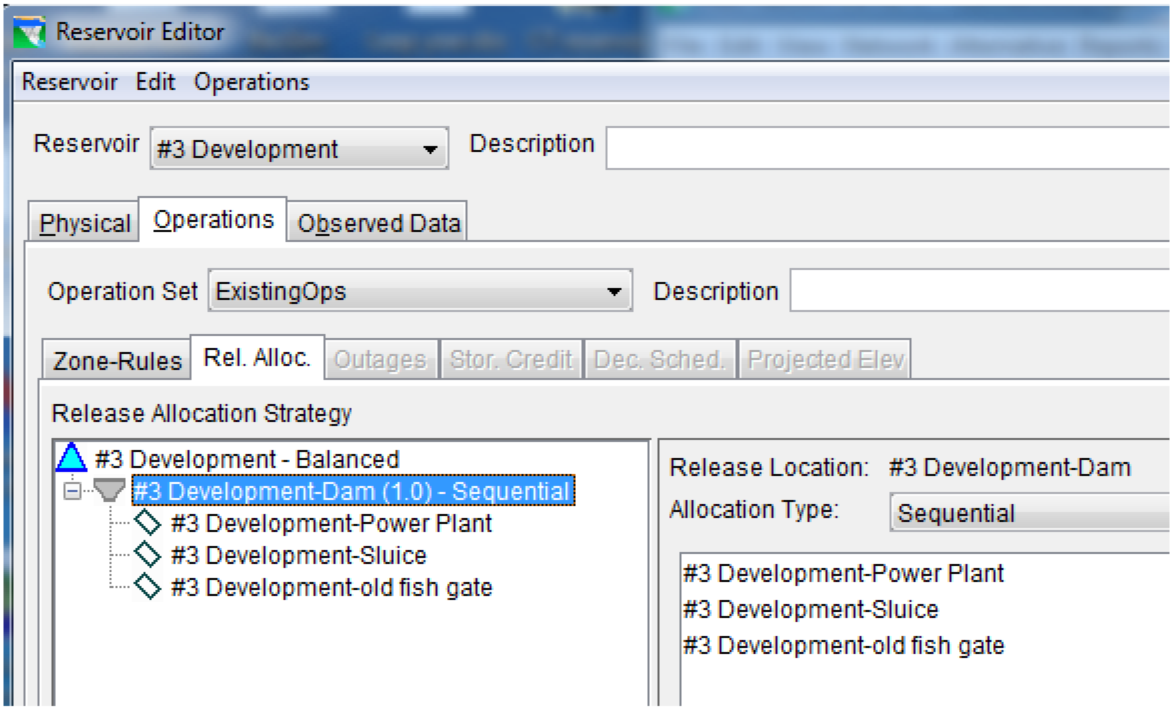


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[31].

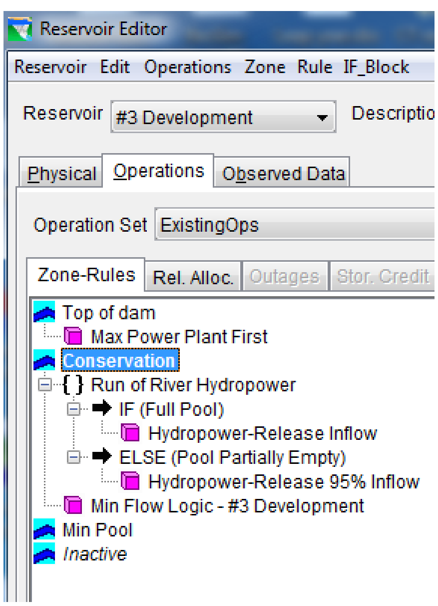


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[31] TransCanada. Deerfield River Operational Constraints. 2012.

C. Rule Descriptions

1. Max Power Plant First

Figure 8 shows the content of “Max Power Plant First” rule. This rule forces the inflow to pass through the power plant first until it reaches the maximum plant capacity.

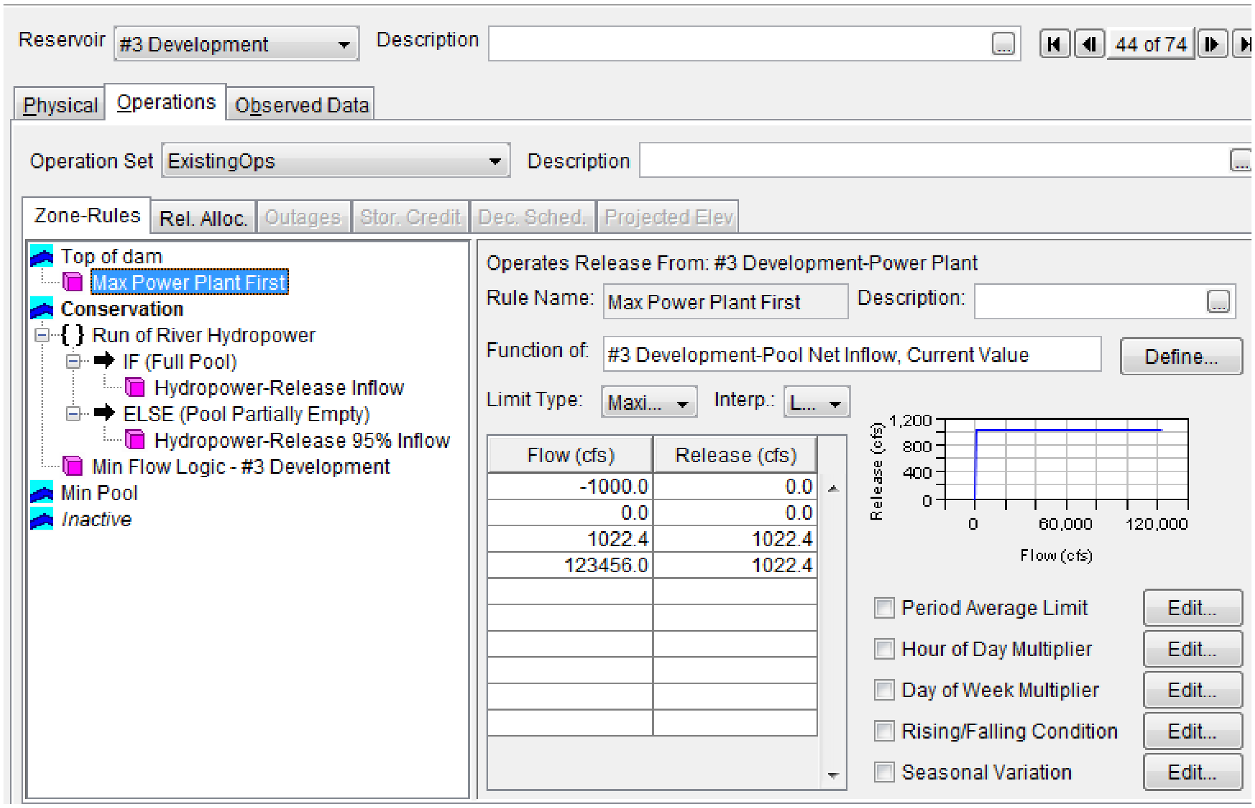
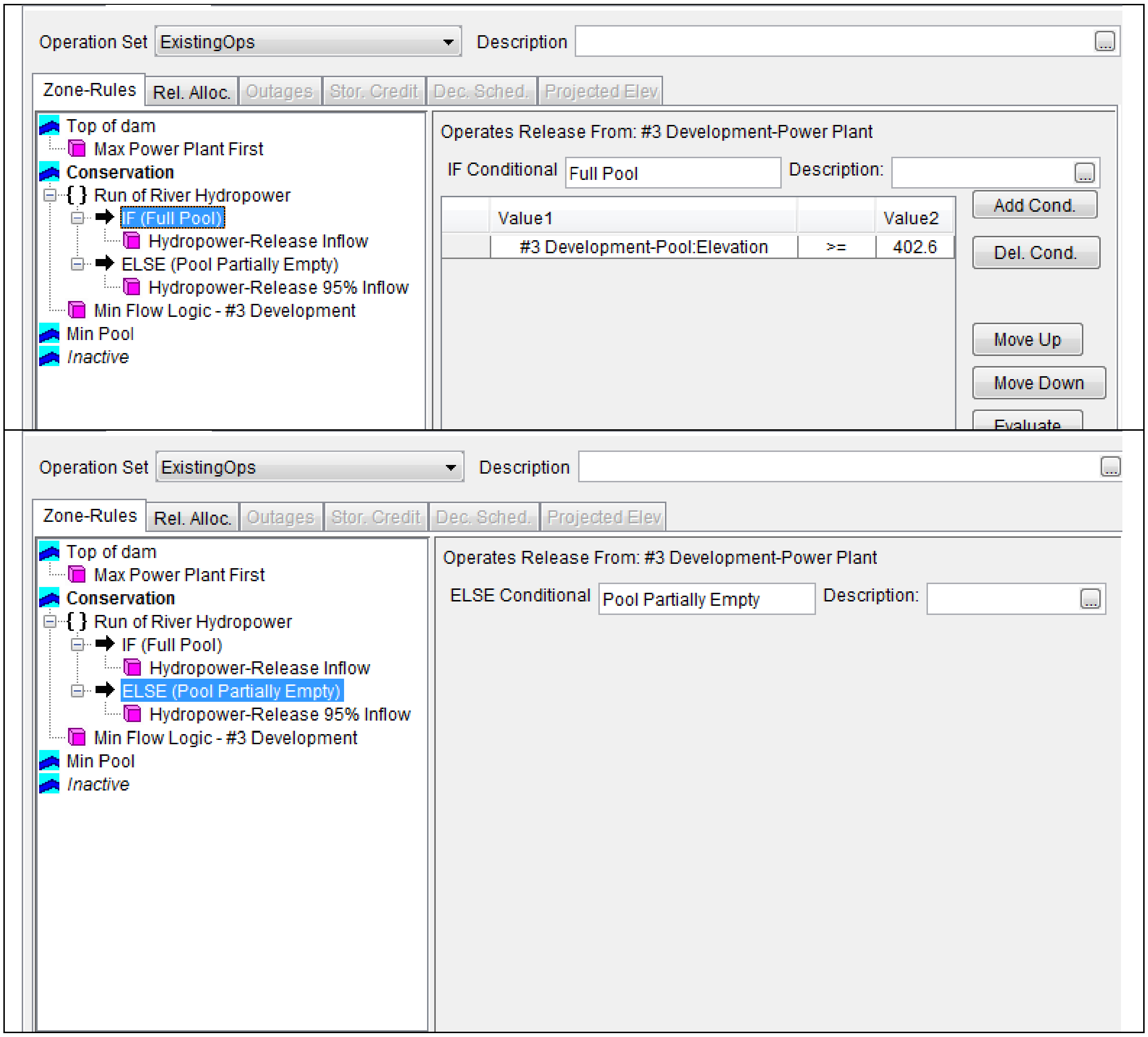


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Power Plant First

2. *Run of River Hydropower*

Figure 9 shows the content of "Run of River Hydropower" rule. This rule release total inflow through power plant when pool elevation is higher than conservation elevation and 95% of inflow when pool elevation is less than conservation zone as per the run-of-river modeling strategy.



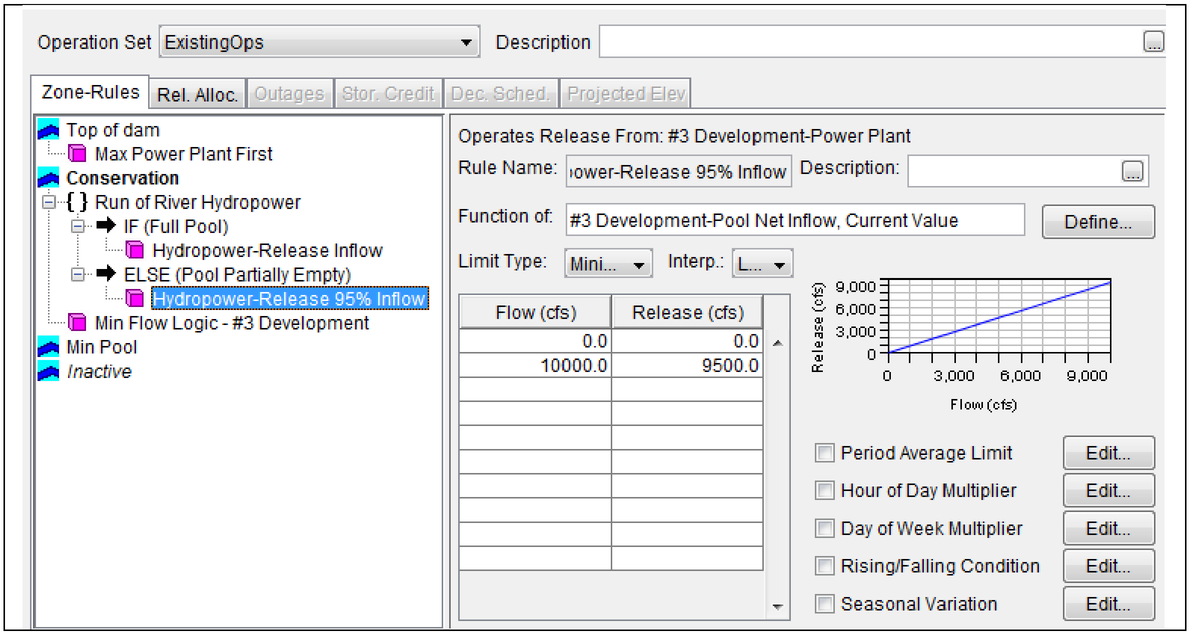


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Run of River hydropower

3. *Min Flow Logic#3 Development*

This rule represents seasonal minimum flow as represented in Figure 10.

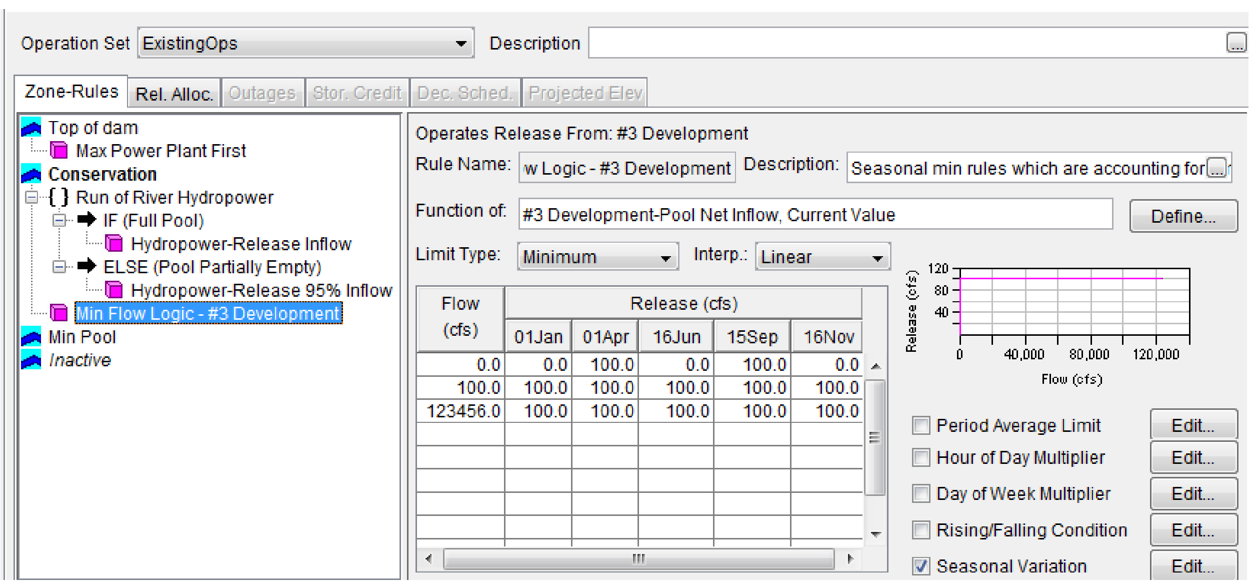


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic #3 Development

Deerfield No.4 Development

I. Overview

Deerfield No. 4 Development is located directly downstream of the Highway 2 bridge on the Deerfield River. It is owned and operated by TransCanada Hydro Northeast Inc. for hydropower generation on a run-of-river basis.

Figure 1 shows the location of Deerfield No. 4 dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Deerfield No. 4 dam.

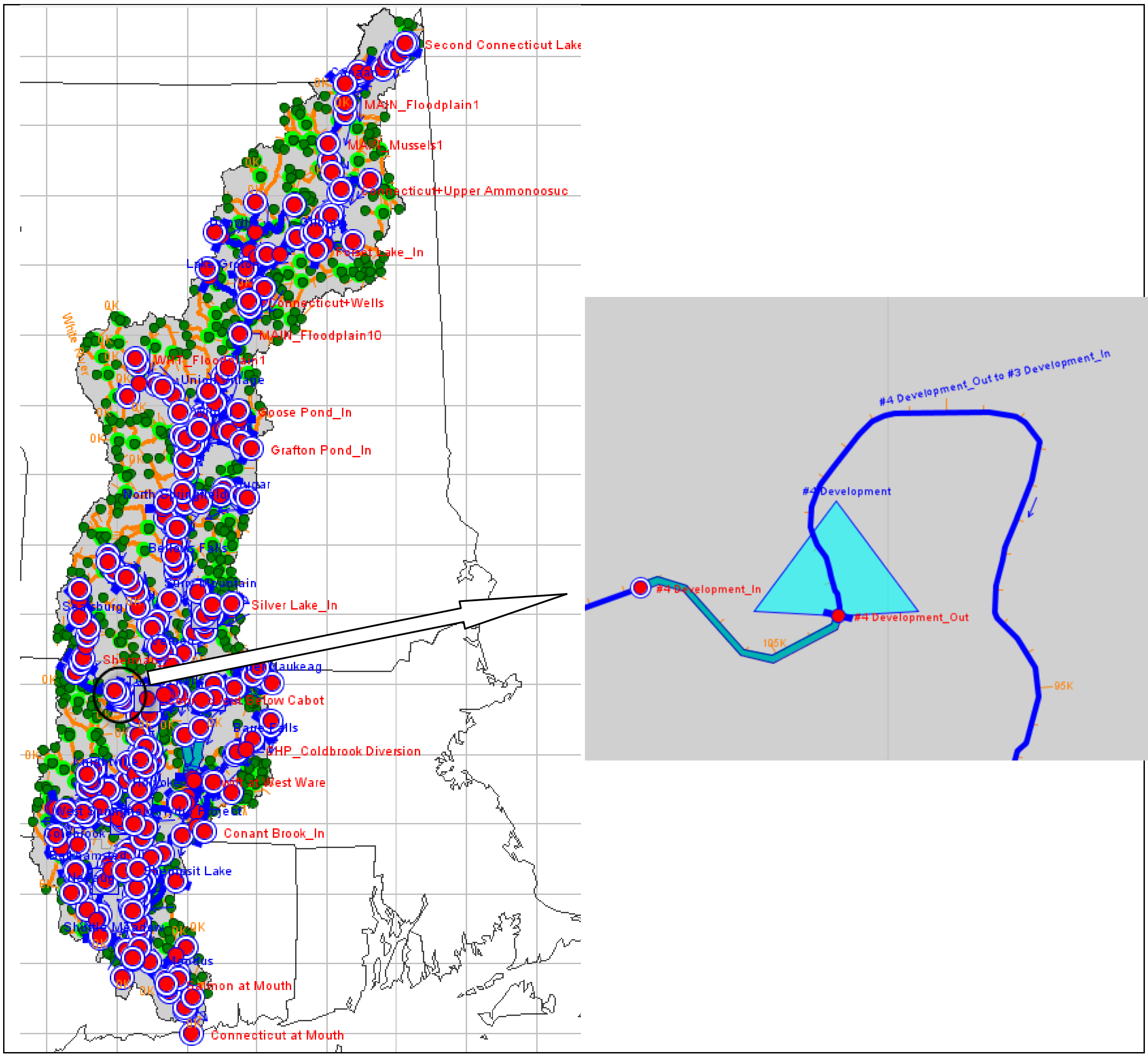


Figure 1: HEC-ResSim Map Display Showing Location of Deerfield No.4

Figure 2: Photo of Deerfield No. 4 Development

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[32]. The dam consists of five types of outlets: (1) controlled fish gate, (2) controlled sluice No.1&2, (3) controlled sluice No.3, (4) uncontrolled flashboard spillway, and (5) power plant as shown in Figure 4.

[32] Data provided by TransCanada

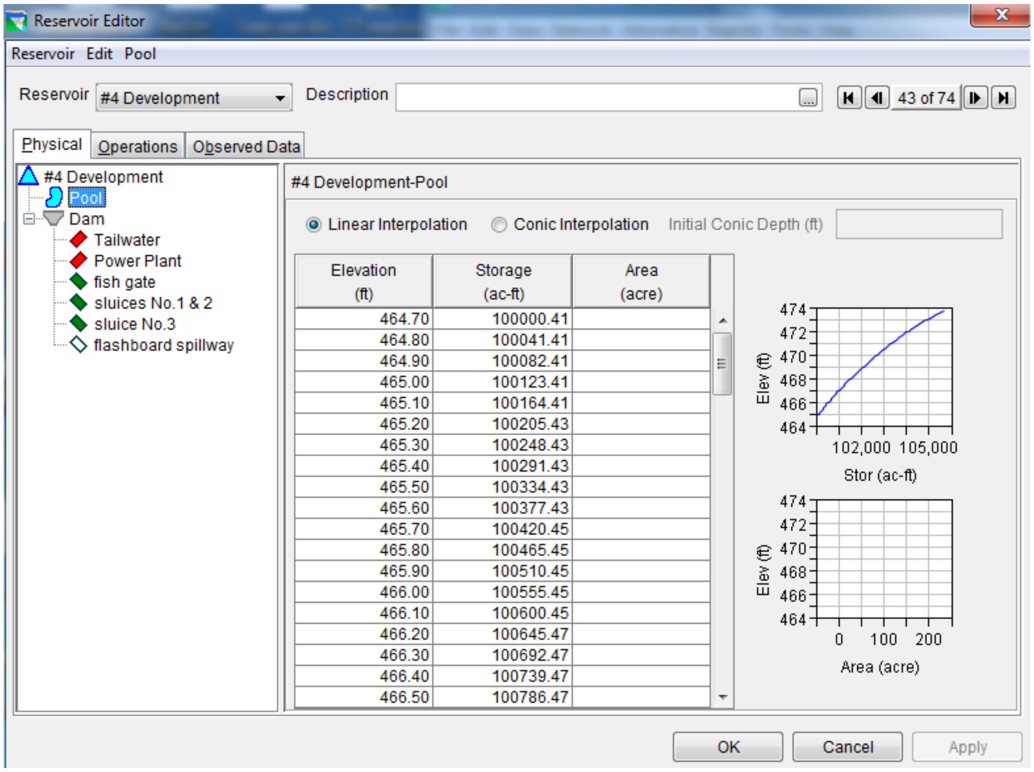


Figure 3: Reservoir Editor: Physical Tab -- Pool

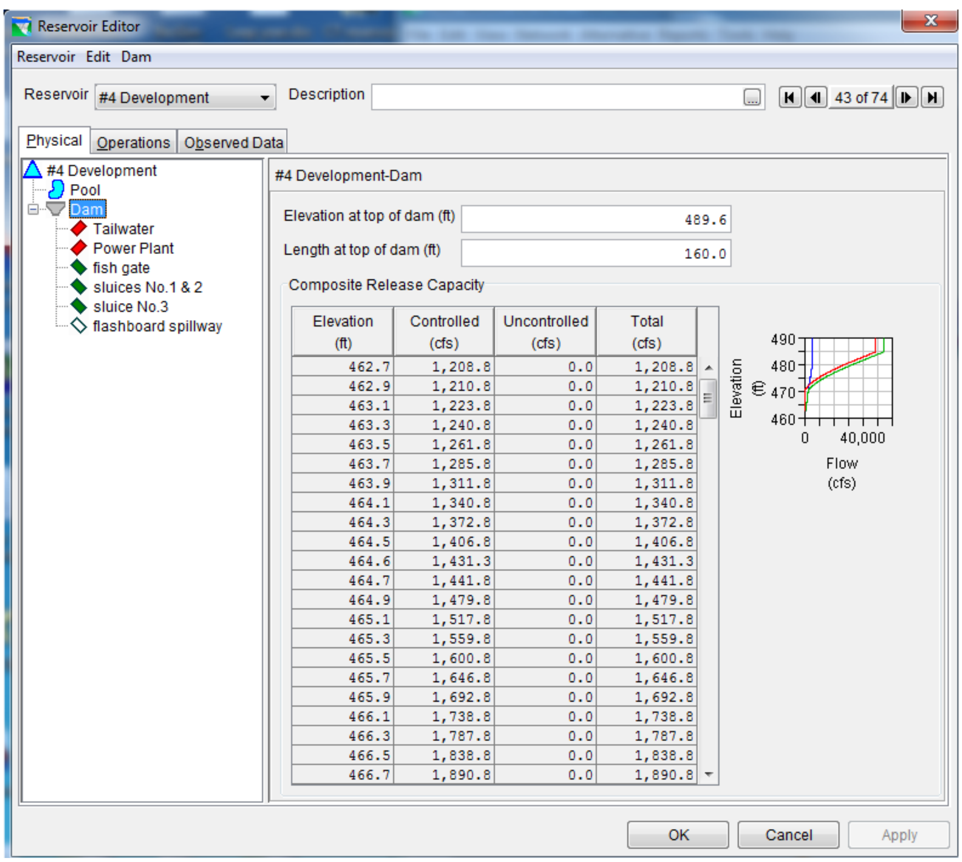


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Deerfield No. 4's "ExistingOps" operational zones, which consist of zones of Top of dam (489.6 ft), conservation (469.6 ft), Min Pool (464.6 ft), and Inactive zone (419.6 ft)[1].

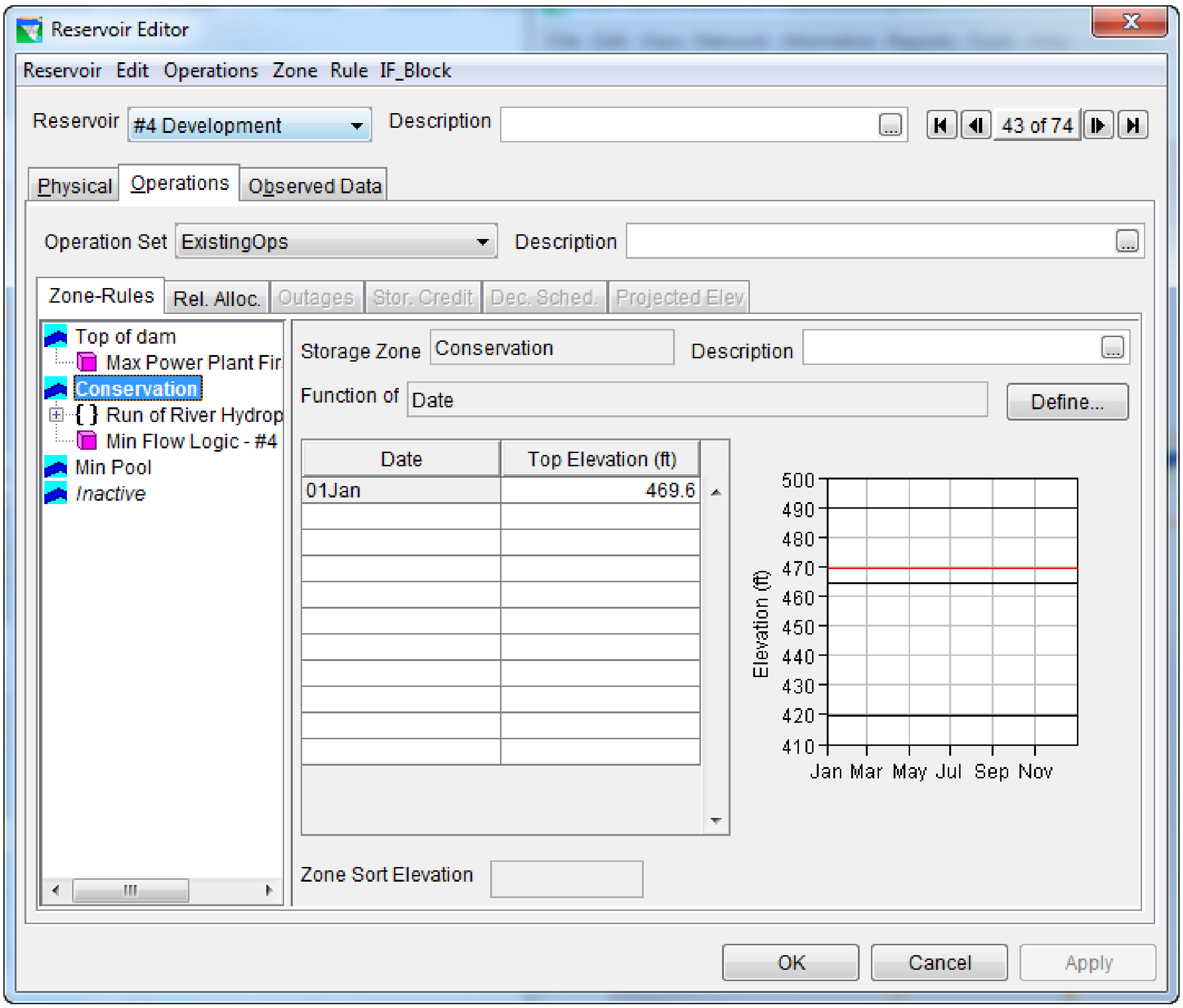


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Buford Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The fish gate the remainder of the release until it reaches capacity. After the capacity through the fish gate is reached, the remainder of the release goes through sluice No. 1, 2, and 3 respectively.

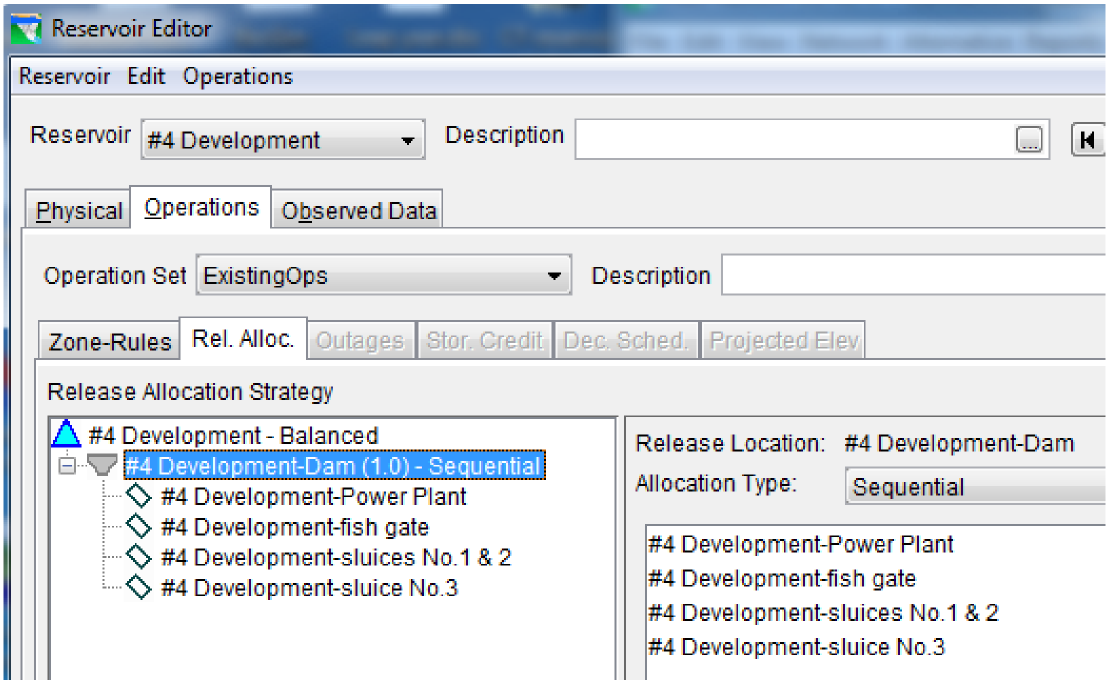


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[33].

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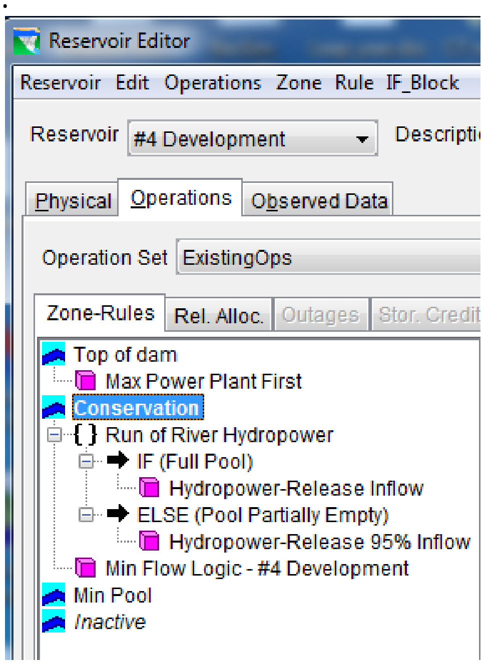


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[33] TransCanada. Deerfield River Operational Constraints. 2012.

C. Rule Descriptions

1. Max Power Plant First

Figure 8 shows the content of "Max Power Plant First" rule. This rule forces the inflow to pass through the power plant first until it reaches the maximum plant capacity.

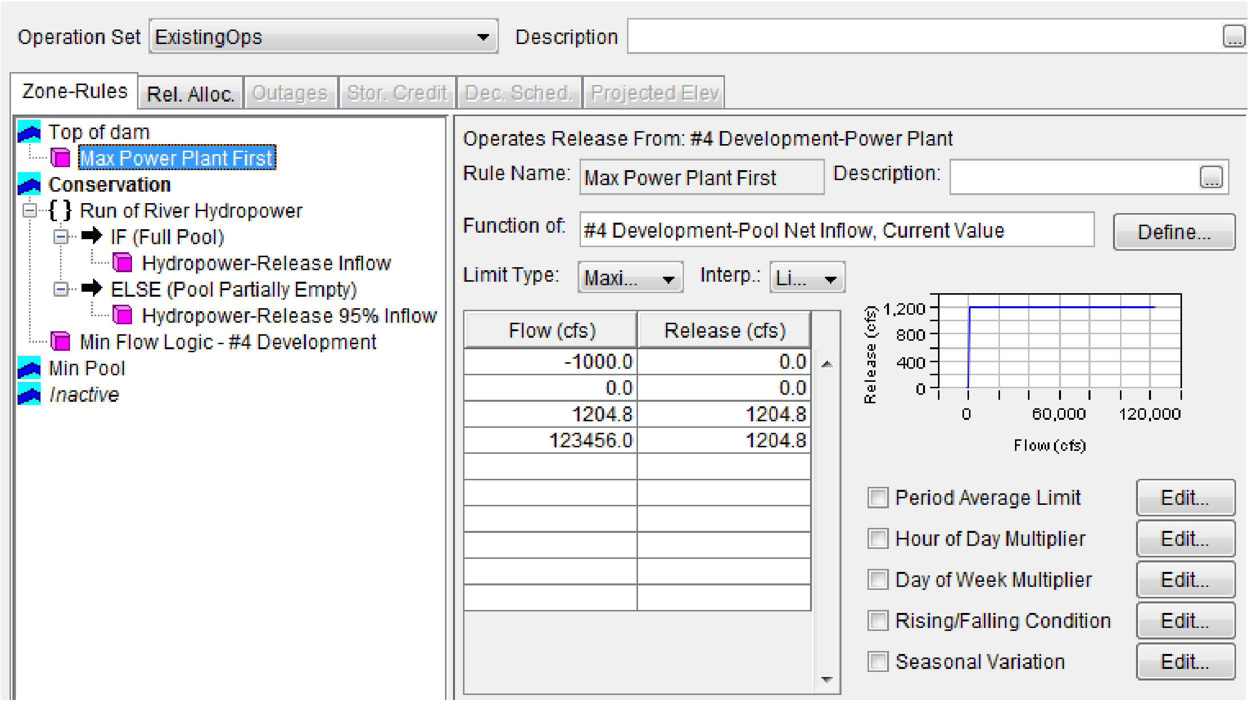
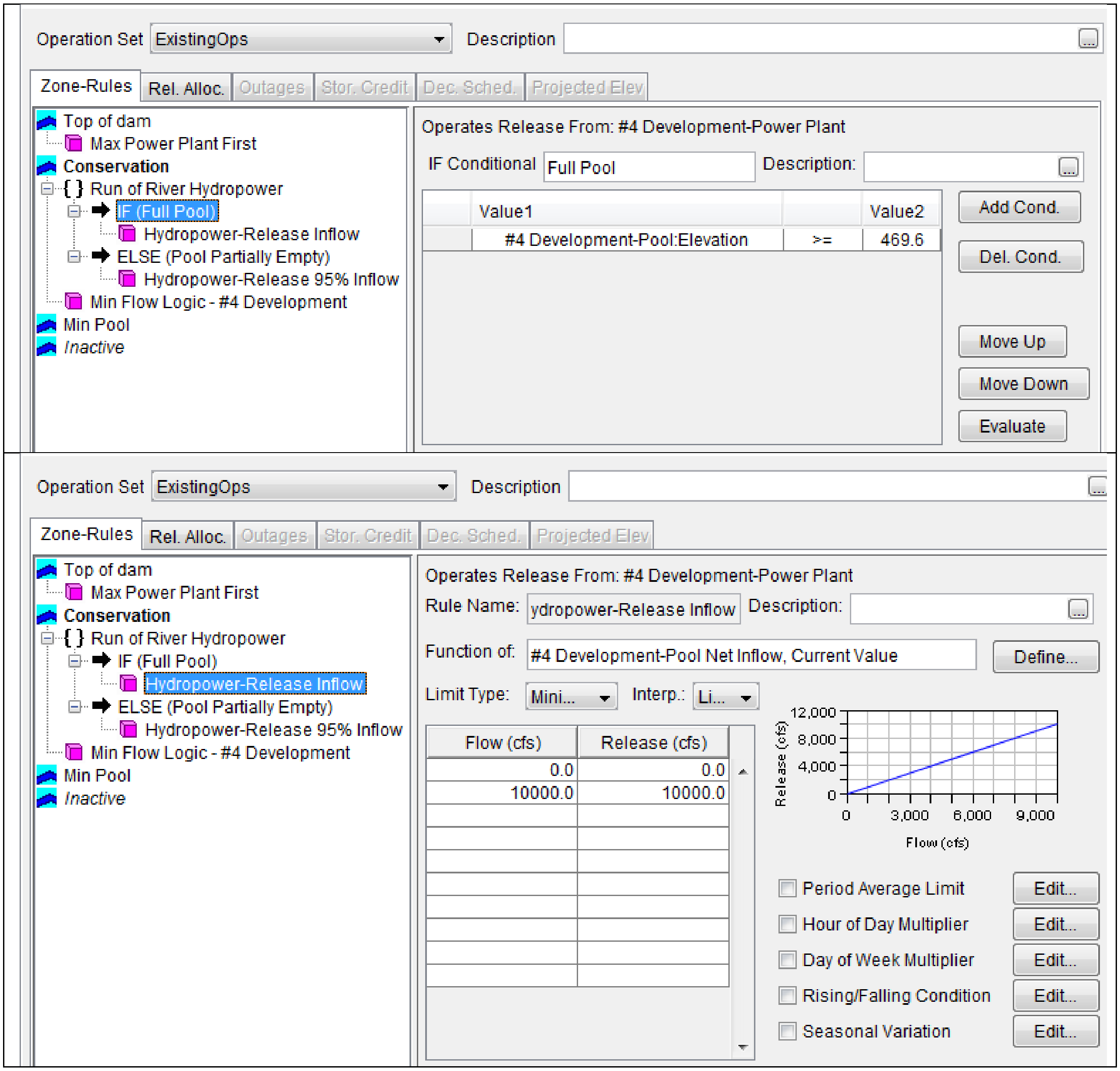


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Power Plant First

2. Run of River Hydropower

Figure 8 shows the content of "Run of River Hydropower" rule. This rule release total inflow through power plant when pool elevation is higher than conservation elevation and 95% of inflow when pool elevation is less than conservation zone as per the run-of-river modeling strategy.



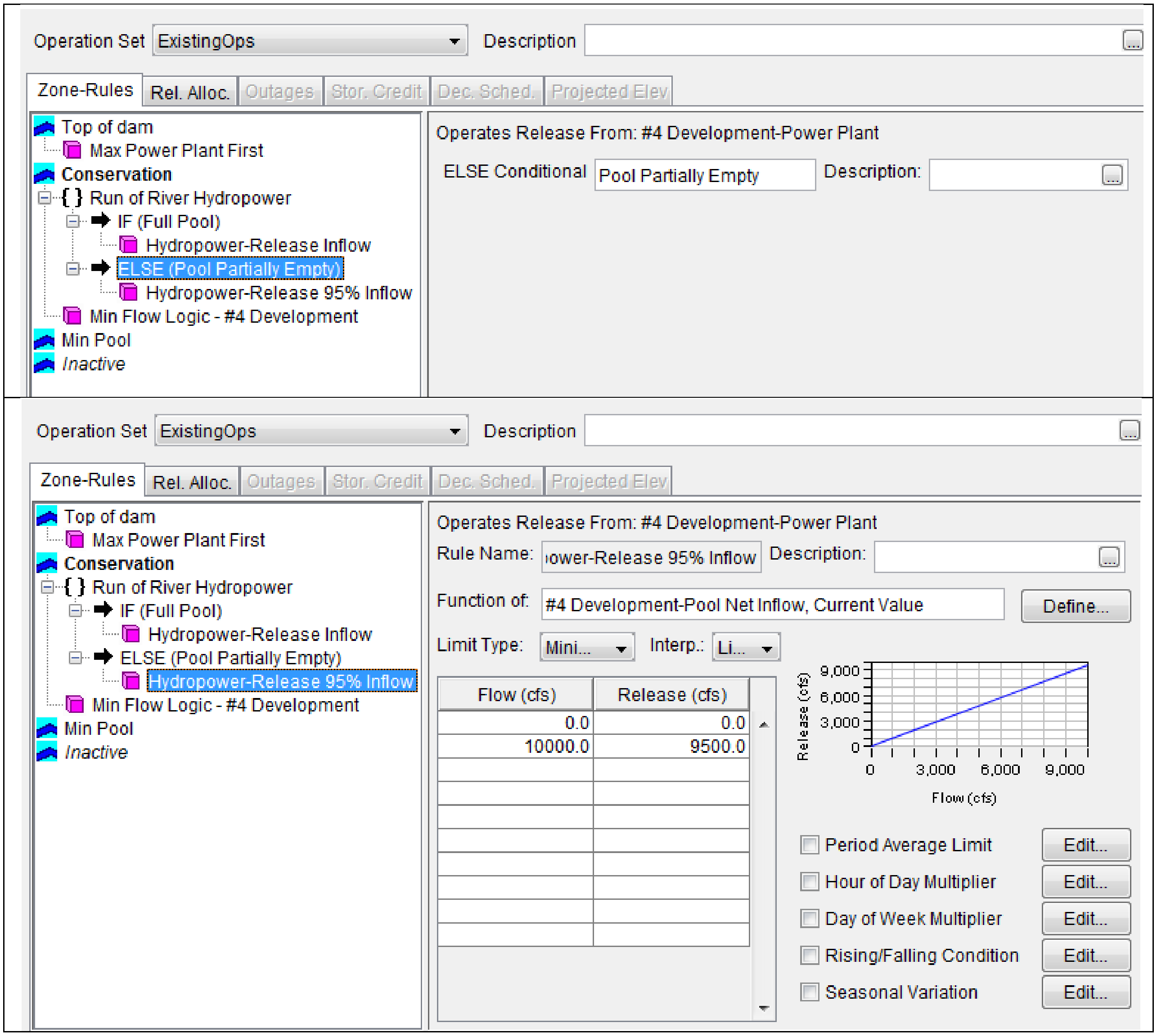


Figure 8 Reservoir Editor: Operations Tab – Existing Ops OpSet – Run of River hydropower

3. Min Flow Logic#4 Development

This rule represents seasonal minimum flow as represented in Figure 9.

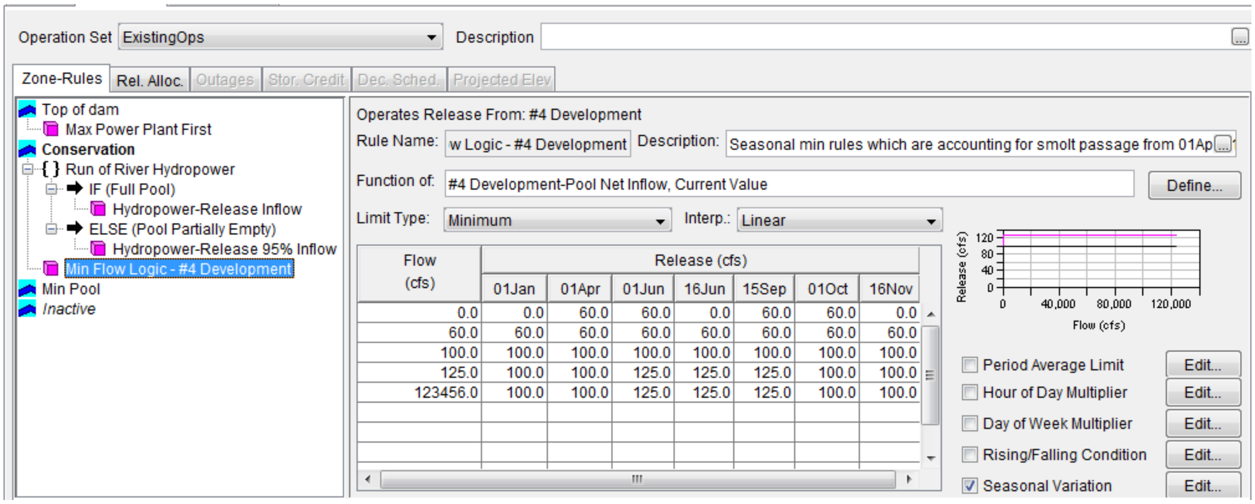


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic #4 Development

Deerfield No. 5 Development

I. Overview

Deerfield No. 5 Development is located in the town of Monroe, MA on the Deerfield River. It is owned and operated by TransCanada Hydro Northeast Inc. for hydropower generation on a run-of-river basis.

Figure 1 shows the location of Deerfield No. 5 dam as it is represented in the HEC-ResSim model .Figure 2 shows the photo of Deerfield No.5 dam.

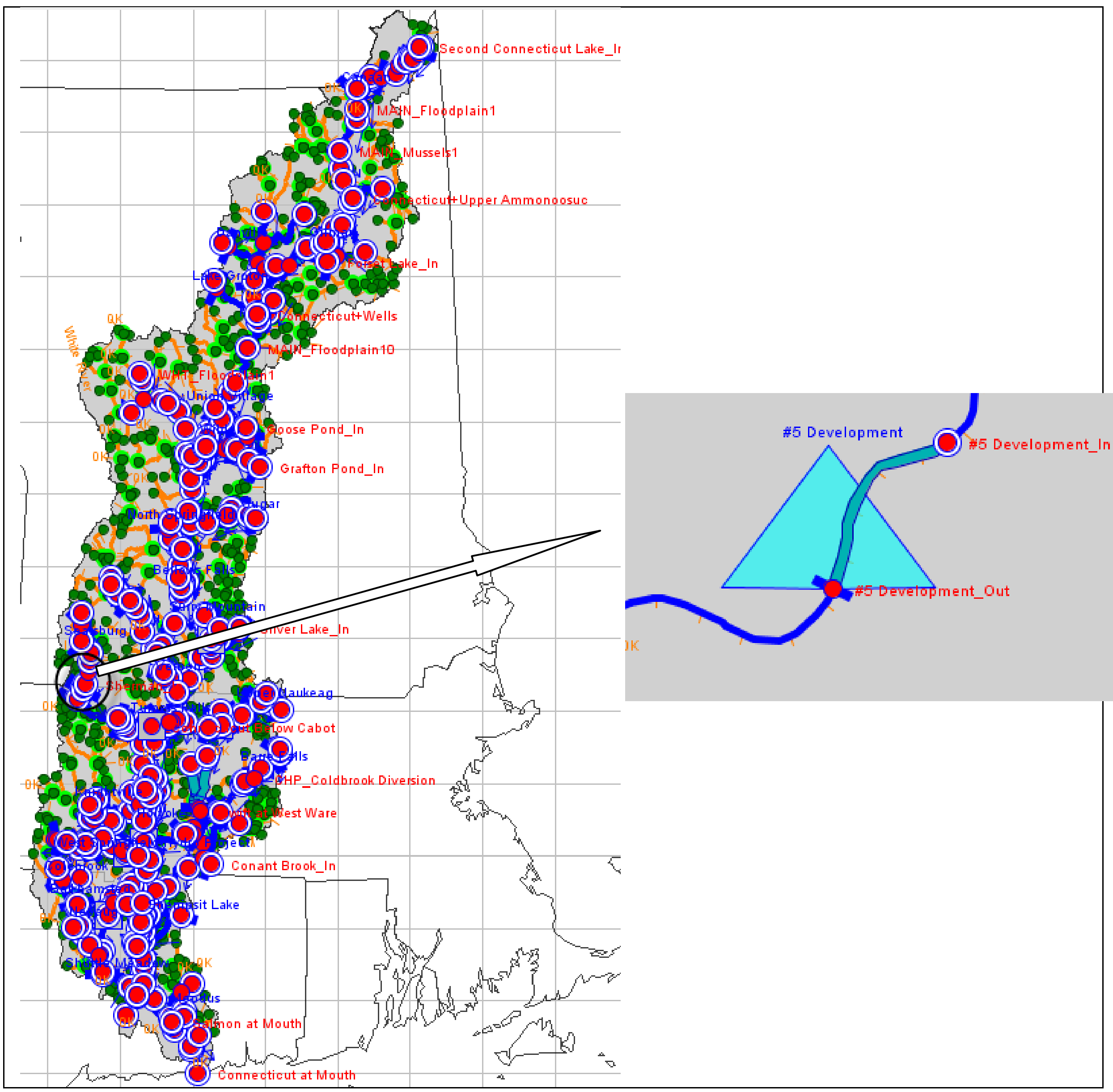


Figure 1: HEC-ResSim Map Display Showing Location of Deerfield No.5


Figure 2: Photo of Deerfield No.5 Development

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[34]. The dam consists of five types of outlets: (1) controlled sluice gate, (2) controlled spillway, (3) controlled Flap gate, (4) controlled flood gate, and (5) power plant as shown in Figure 4.

[34] Data provided by TransCanada

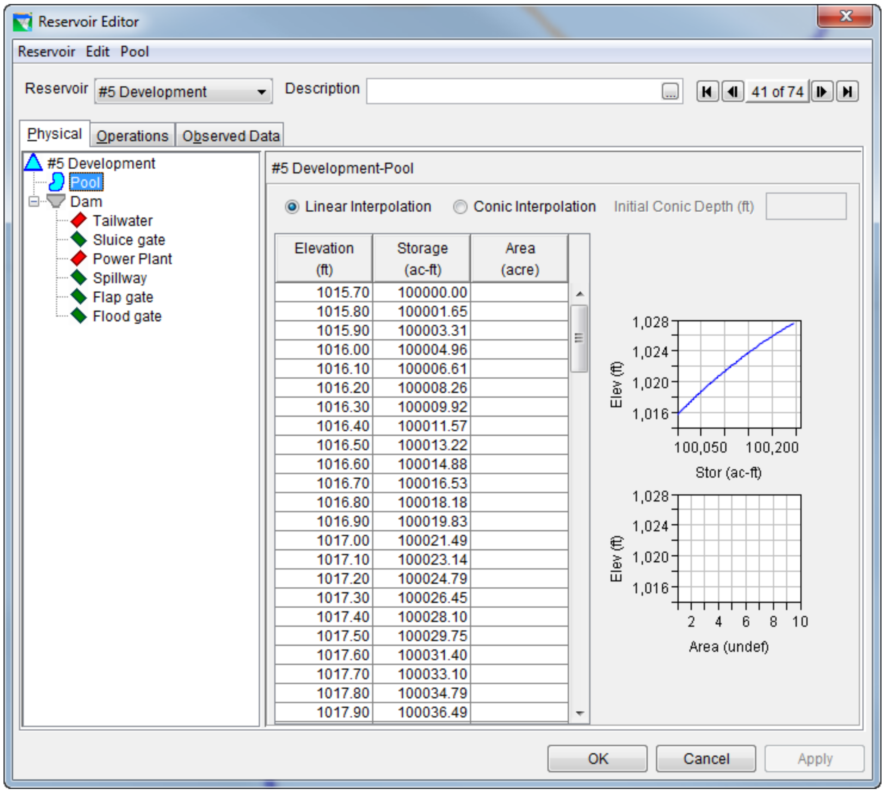


Figure 3: Reservoir Editor: Physical Tab -- Pool

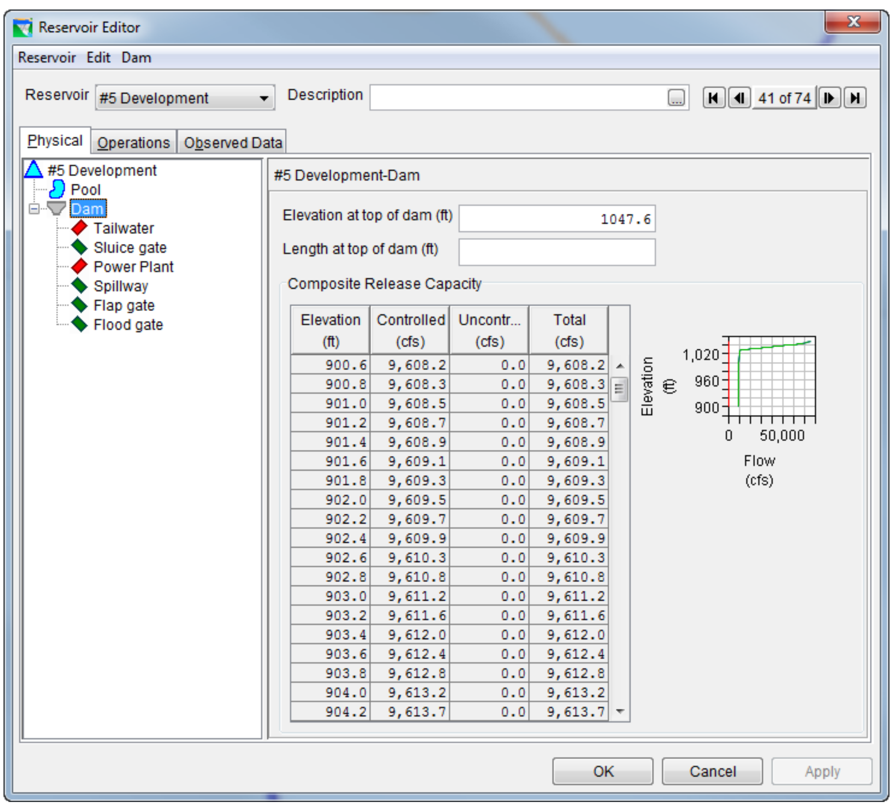


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Deerfield No. 5's "ExistingOps" operational zones, which consist of zones of Top of dam (1047.6 ft), Conservation (1027.6 ft), Min Pool (1017.6 ft), and Inactive zone (970 ft)[1].

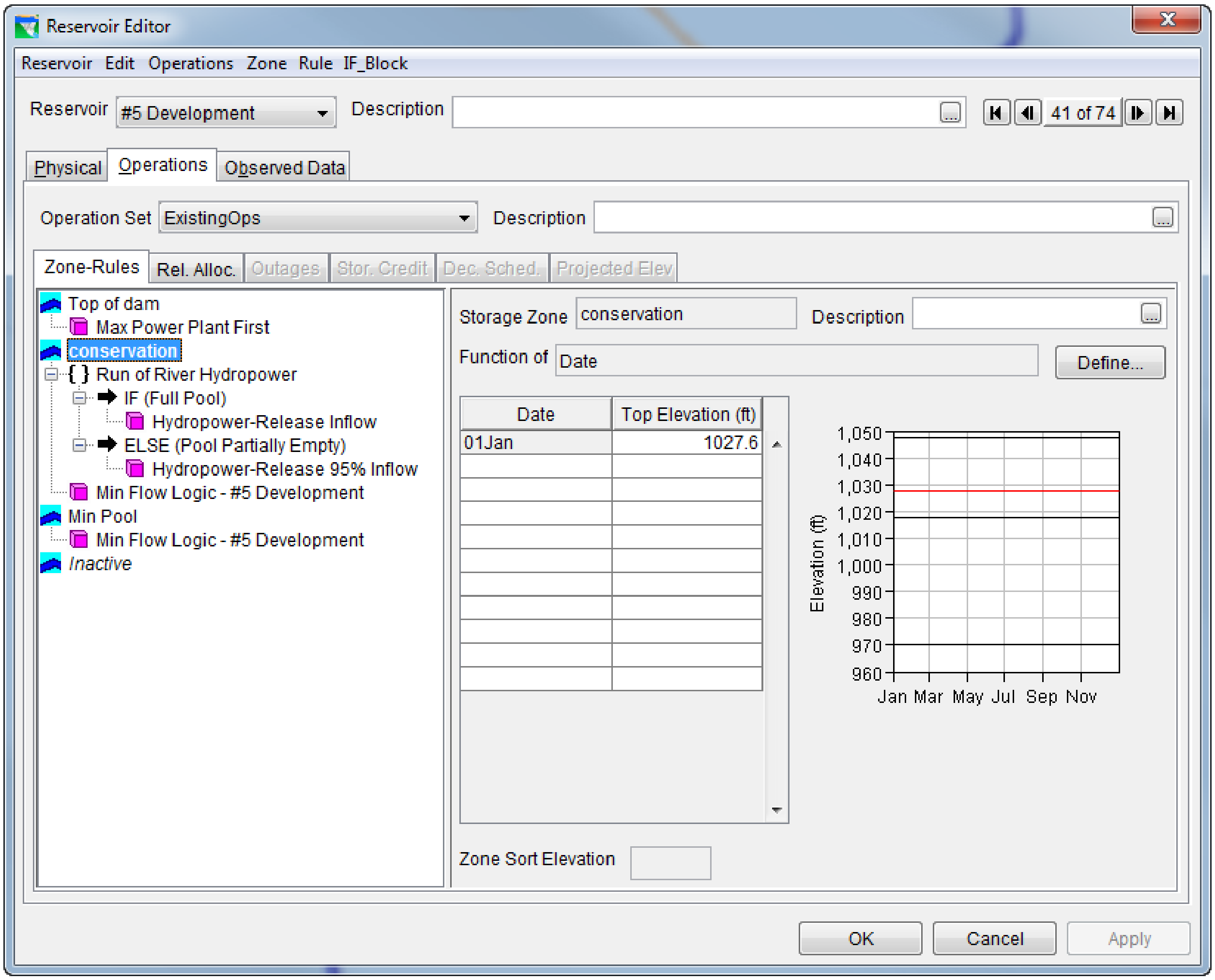


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Buford Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The spillway the remainder of the release until it reaches capacity. After the capacity through the spillway is reached, the remainder of the release goes through sluice gate, Flap gate, and Flood gate respectively.

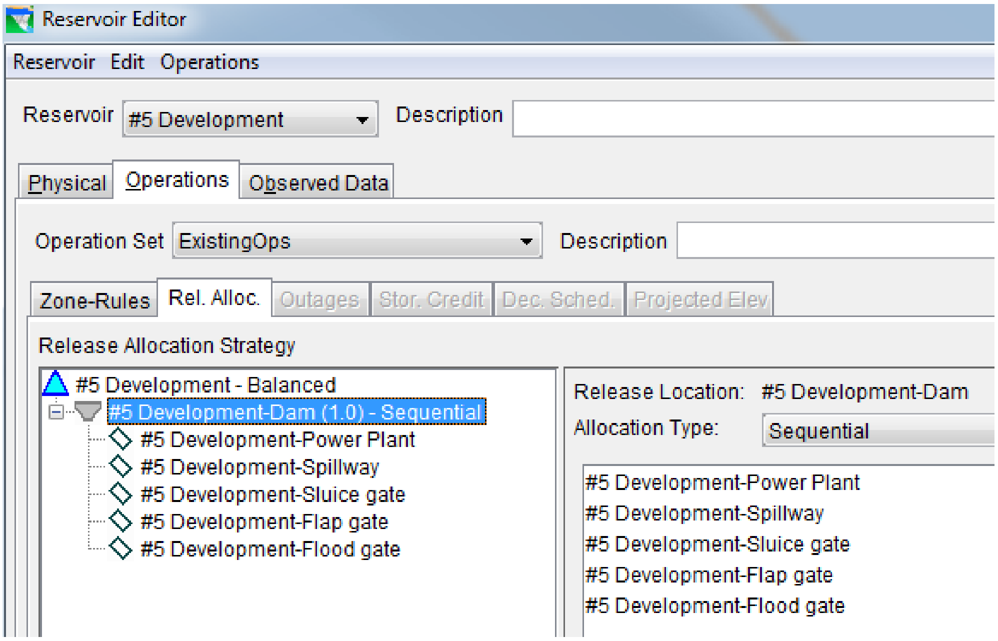


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[35].

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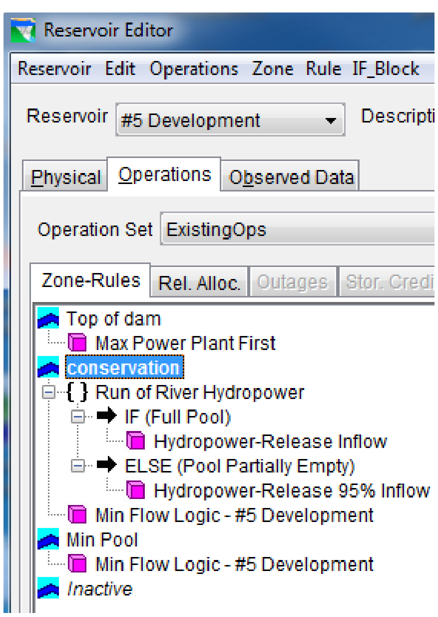


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[35] TransCanada. Deerfield River Operational Constraints. 2012.

C. Rule Descriptions

1. Max Power Plant First

Figure 8 shows the content of "Max Power Plant First" rule. This rule forces the inflow to pass through the power plant first until it reaches the maximum plant capacity.

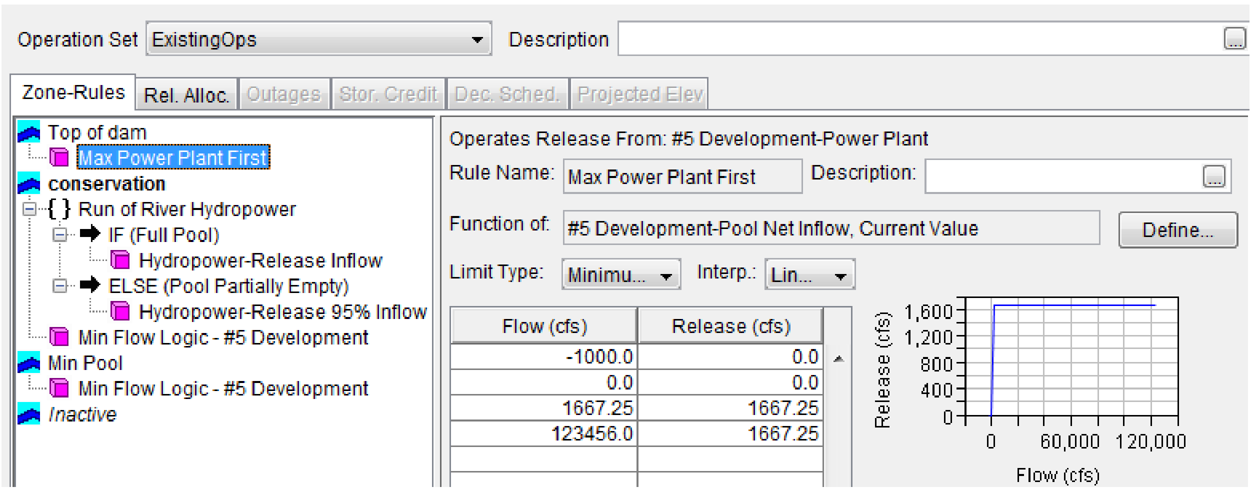
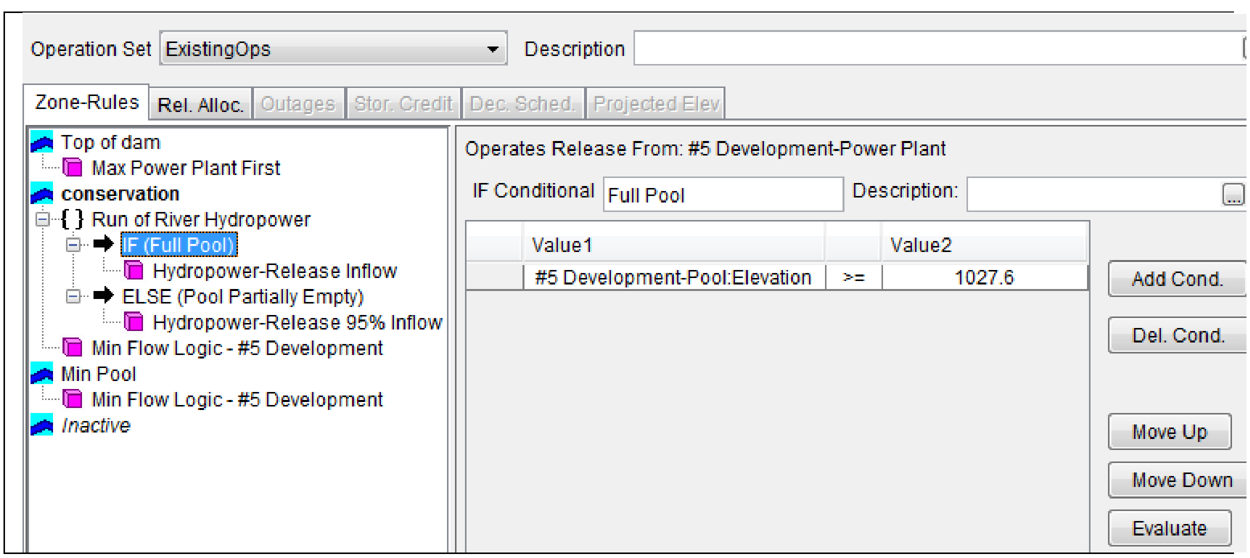
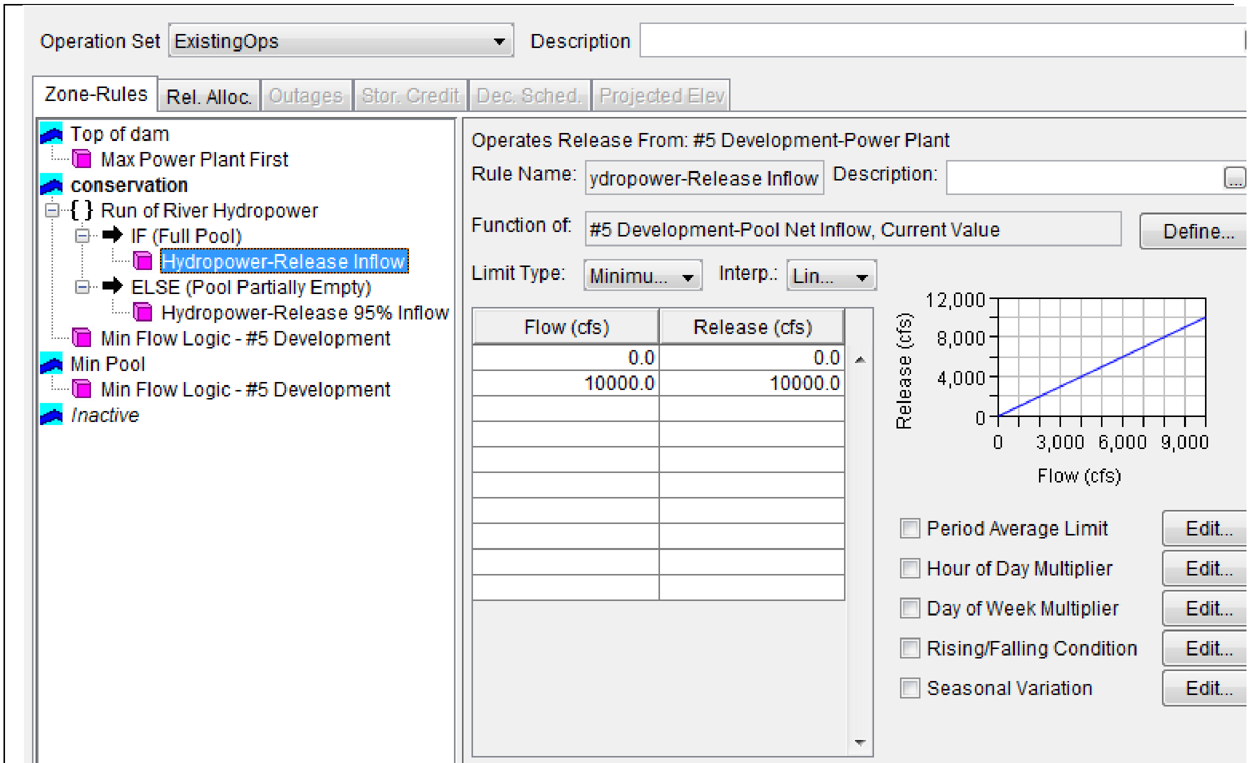


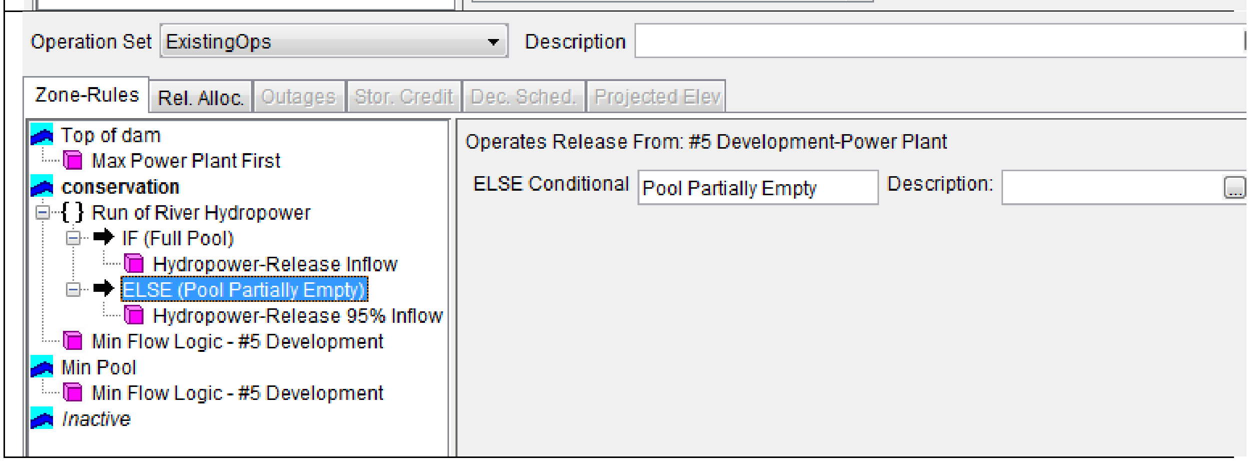
Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Power Plant First

2. Run of River Hydropower

Figure 9 shows the content of "Run of River Hydropower" rule. This rule release total inflow through power plant when pool elevation is higher than conservation elevation and 95% of inflow when pool elevation is less than conservation zone as per the run-of-river modeling strategy.




Operation Set
ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
conservation
{ } Run of River Hydropower
IF (Full Pool)
Hydropower-Release Inflow
ELSE (Pool Partially Empty)
Hydropower-Release 95% Inflow
Min Flow Logic - #5 Development
Min Pool
Min Flow Logic - #5 Development
Inactive
Operates Release From: #5 Development-Power Plant
Rule Name:
ydropower-Release Inflow
Description:
Function of:
#5 Development-Pool Net Inflow, Current Value
Define...
Limit Type:
Minimu...
Interp.:
Lin...
Flow (cfs)
Release (cfs)
0.0
0.0
10000.0
10000.0
12,000
8,000
4,000
0
Release (cfs)
0
3,000
6,000
9,000
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set
ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
conservation
{ } Run of River Hydropower
IF (Full Pool)
Hydropower-Release Inflow
ELSE (Pool Partially Empty)
Hydropower-Release 95% Inflow
Min Flow Logic - #5 Development
Min Pool
Min Flow Logic - #5 Development
Inactive
Operates Release From: #5 Development-Power Plant
ELSE Conditional
Pool Partially Empty
Description:

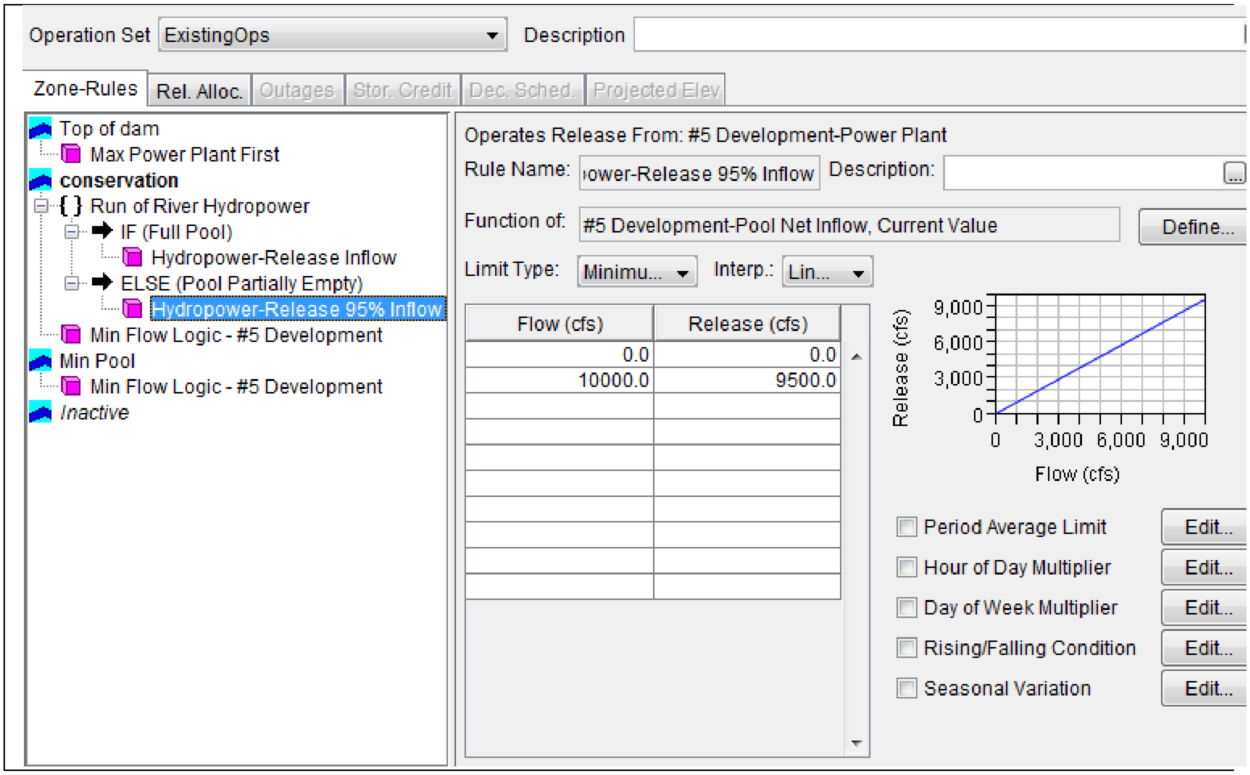


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Run of River hydropower

3. Min Flow Logic #5 Development

This rule represents a minimum release based on inflow as represented in Figure 10.

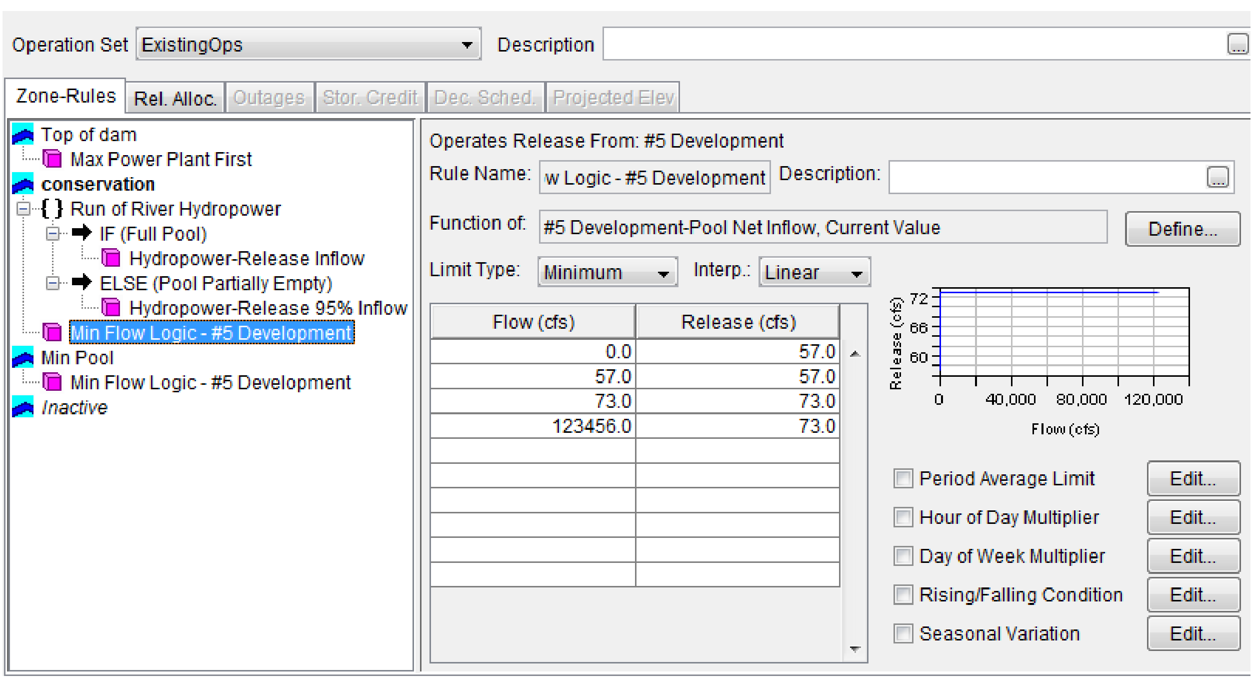


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic #5 Developmen

First Connecticut Lake

I. Overview

First Connecticut Lake dam is located 8 miles upstream of Pittsburg, NH on the mainstem Connecticut River. It is owned and operated by TransCanada Hydro Northeast Inc. as a storage reservoir to make releases to its downstream hydro facilities.

Figure 1 shows the location of Second Connecticut Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from Second Connecticut Dam.

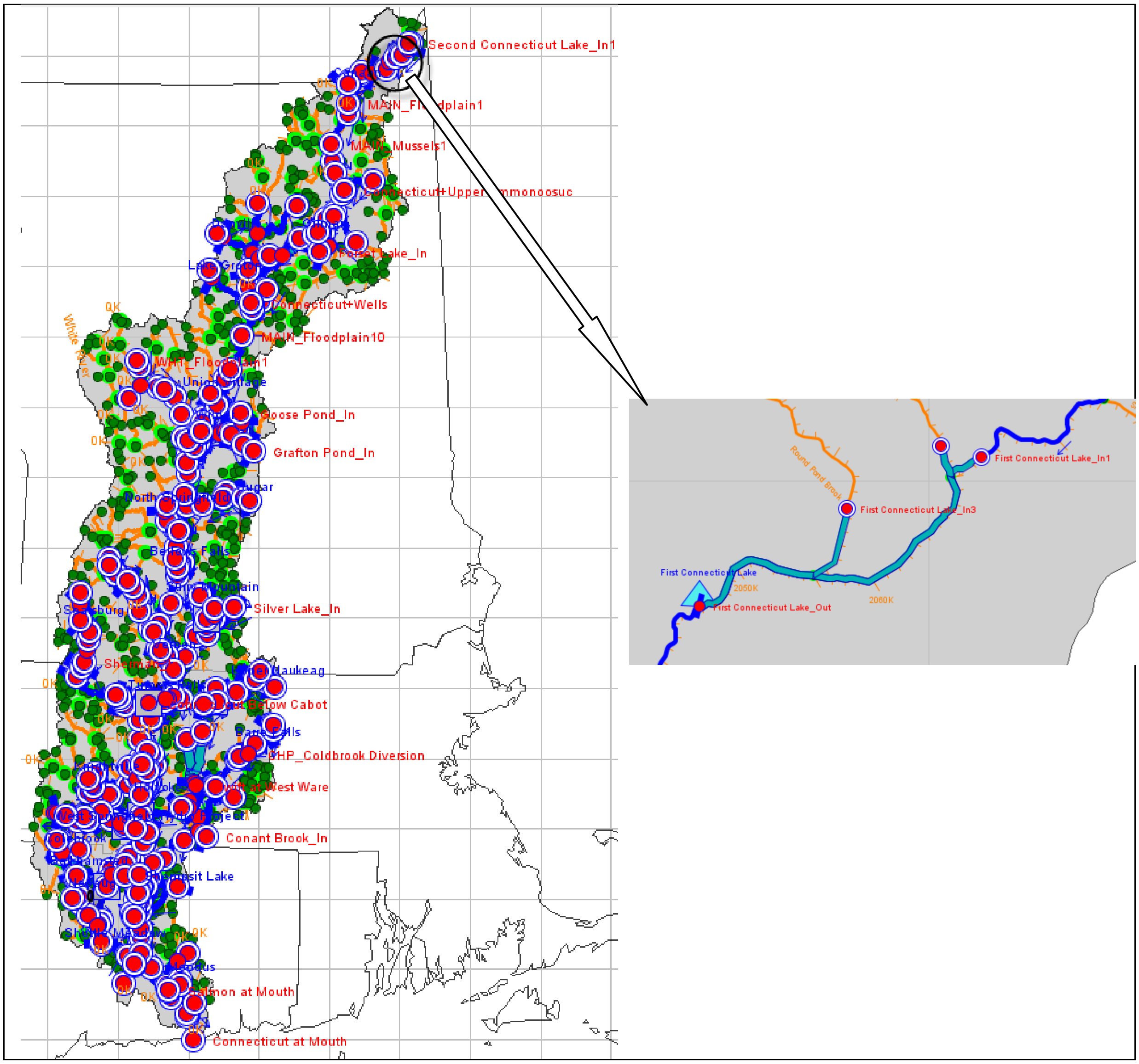


Figure 1: HEC-ResSim Map Display Showing Location of First Connecticut Dam

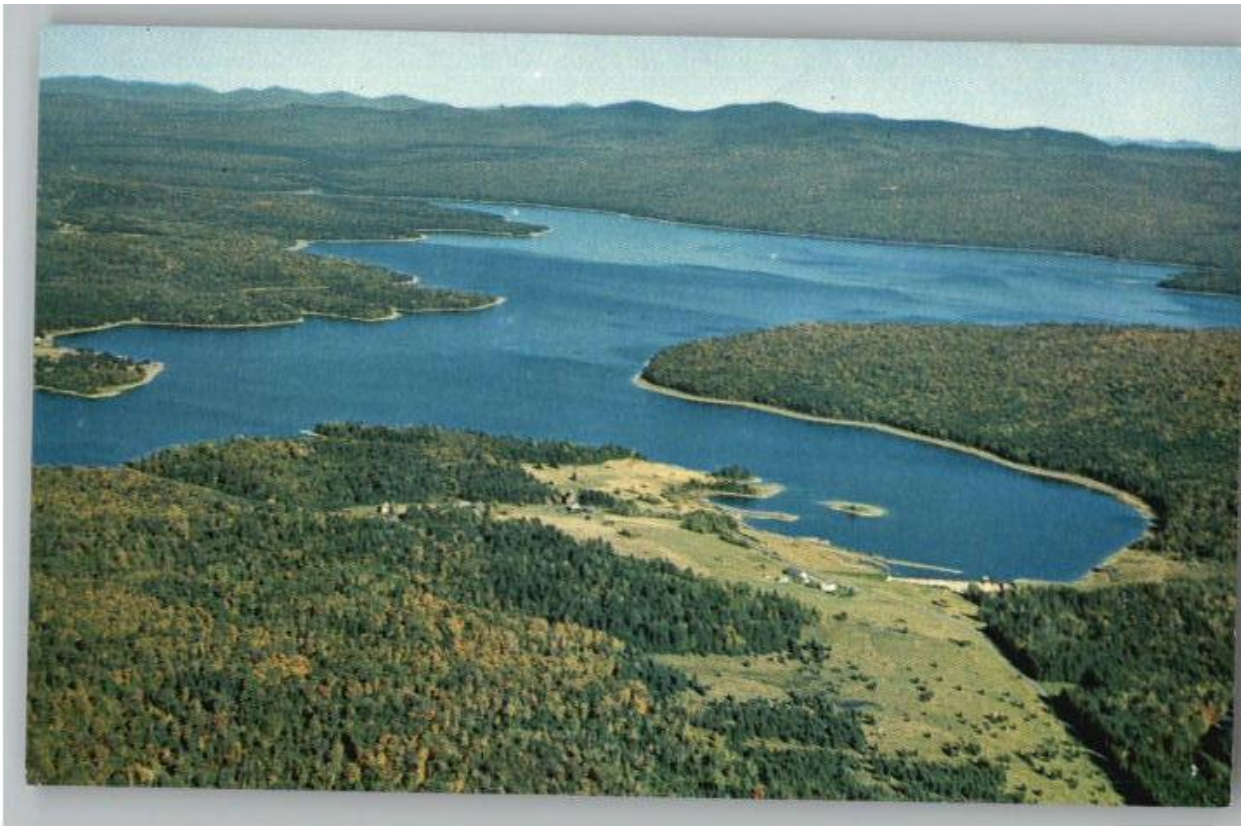


Figure 2: Photo of First Connecticut Lake

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[36]. The dam consists of four types of outlets: (1) controlled outlet, (2) uncontrolled spillway, (3) controlled Log way, and (4) controlled Fish Pipe as shown in Figure 4.

[36] Data provided by TransCanada

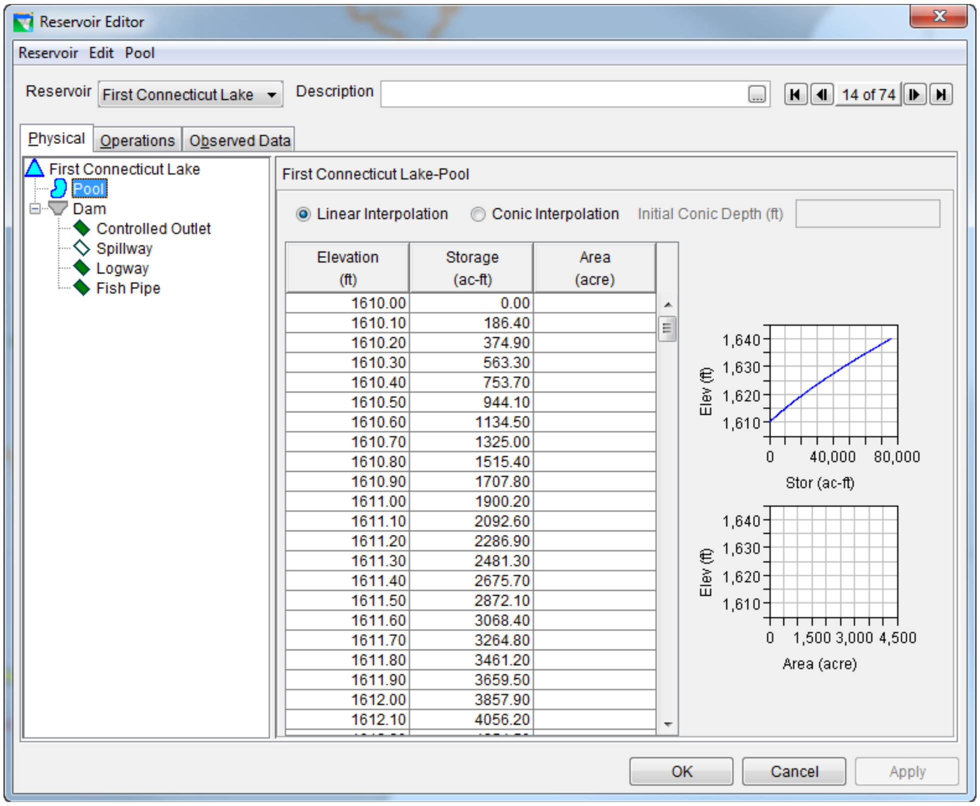


Figure 3: Reservoir Editor: Physical Tab -- Pool

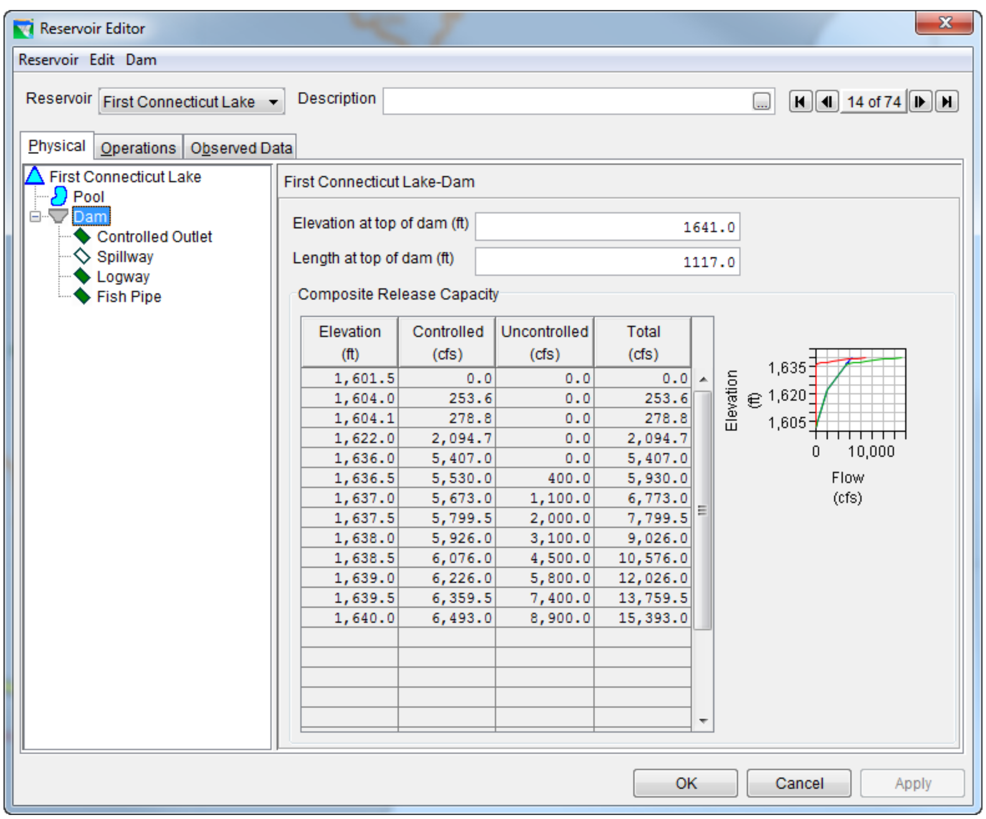


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of First Connecticut Dam's "Existing Ops" operational zones, which consist of zones of Top of Dam (1641 ft), Below Top of Dam (1640 ft), Conservation (1617.262-1637.493 ft), and Inactive zone (1600 ft). The Conservation Pool Elevation curve was created from 10 years of weekly average pool elevation[1].

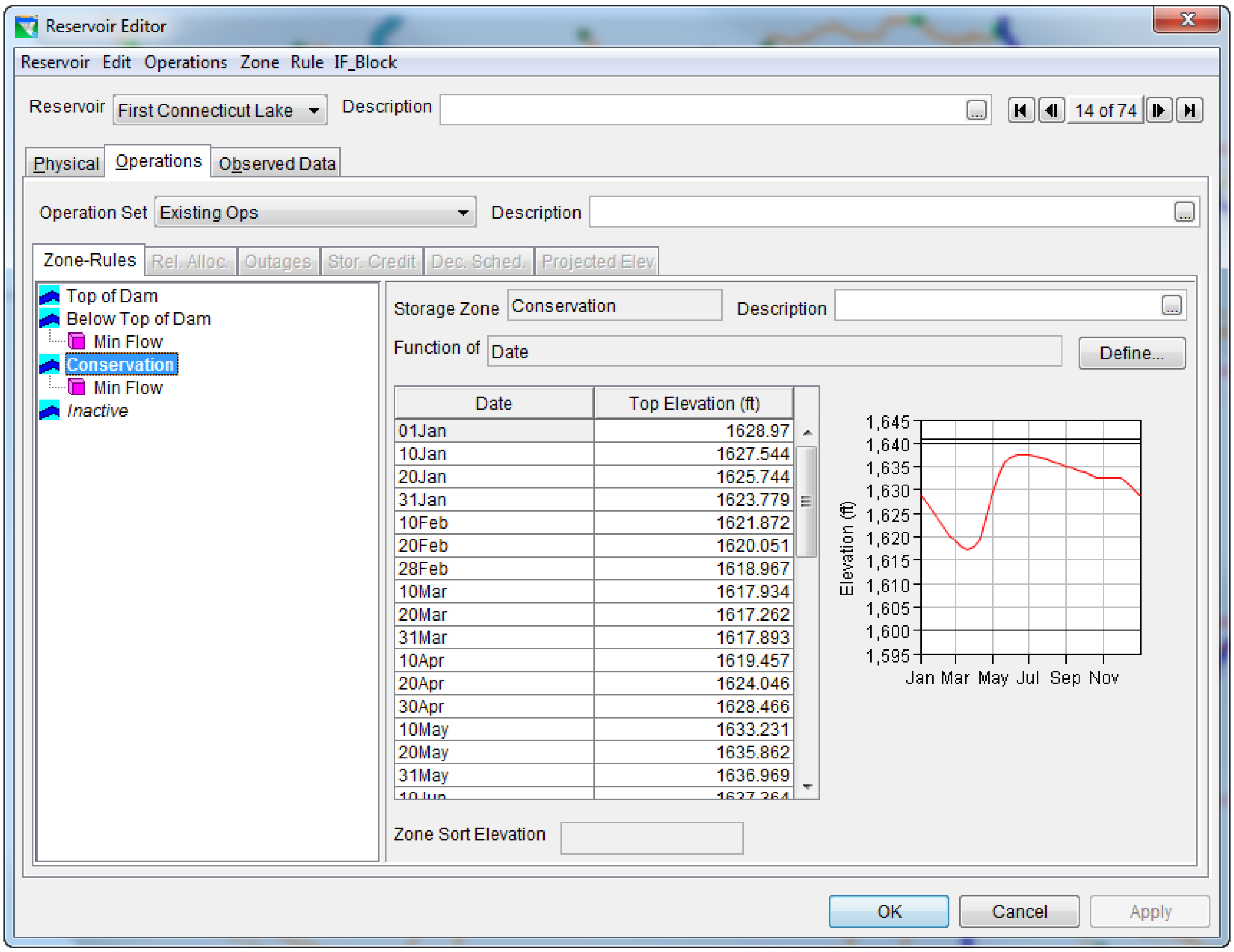


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[37].

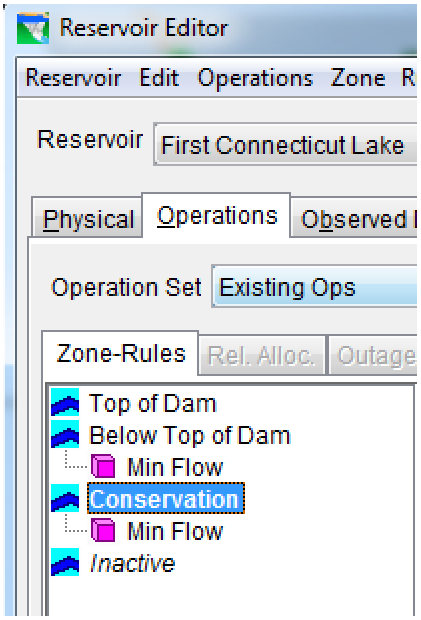


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[37] TransCanada. Connecticut River Operational Constraints. 2012.

C. Rule Descriptions

1. Min Flow

Figure 7 shows the content of "Min Flow" rule. This rule represents the minimum release from dam as a function of date.

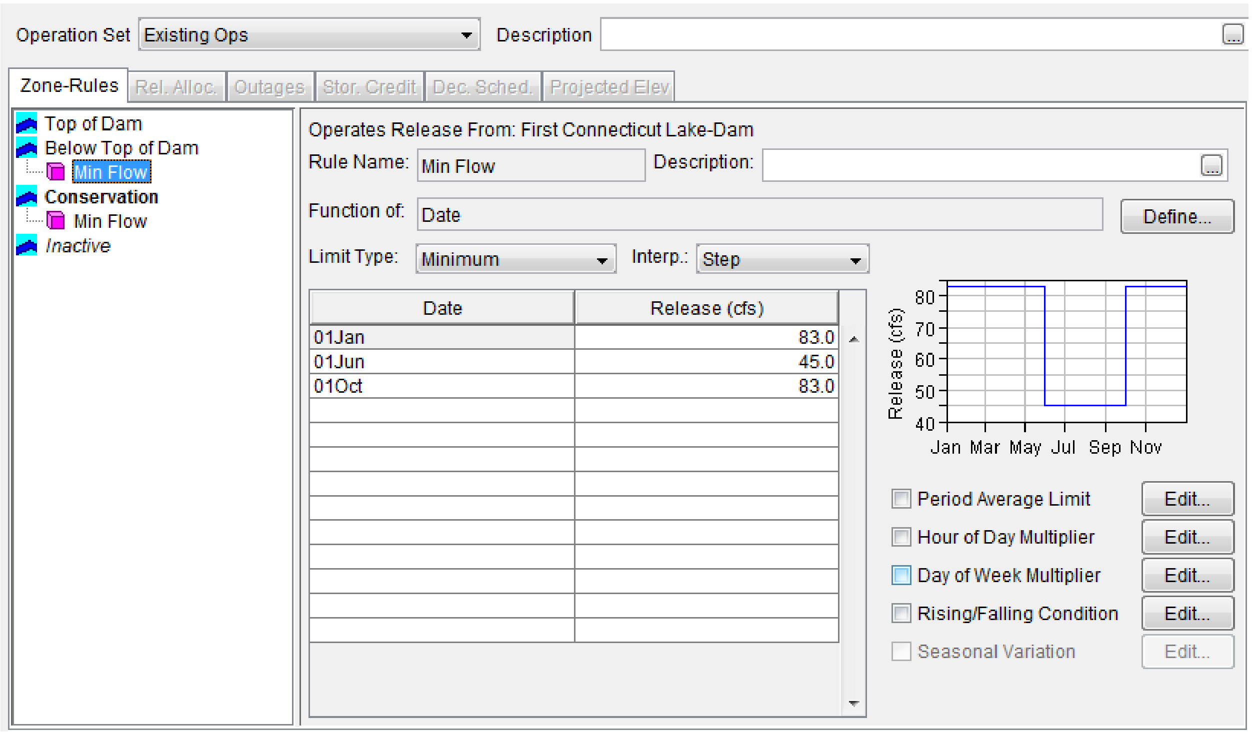


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow

Forest Lake

I. Overview

Forest Lake is a dam located in Whitefield, NH on the Johns River. It is owned and operated by the New Hampshire Water Division and is primarily used for water supply and recreation.

Figure 1 shows the location of Forest Lake Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Forest Lake reservoir.

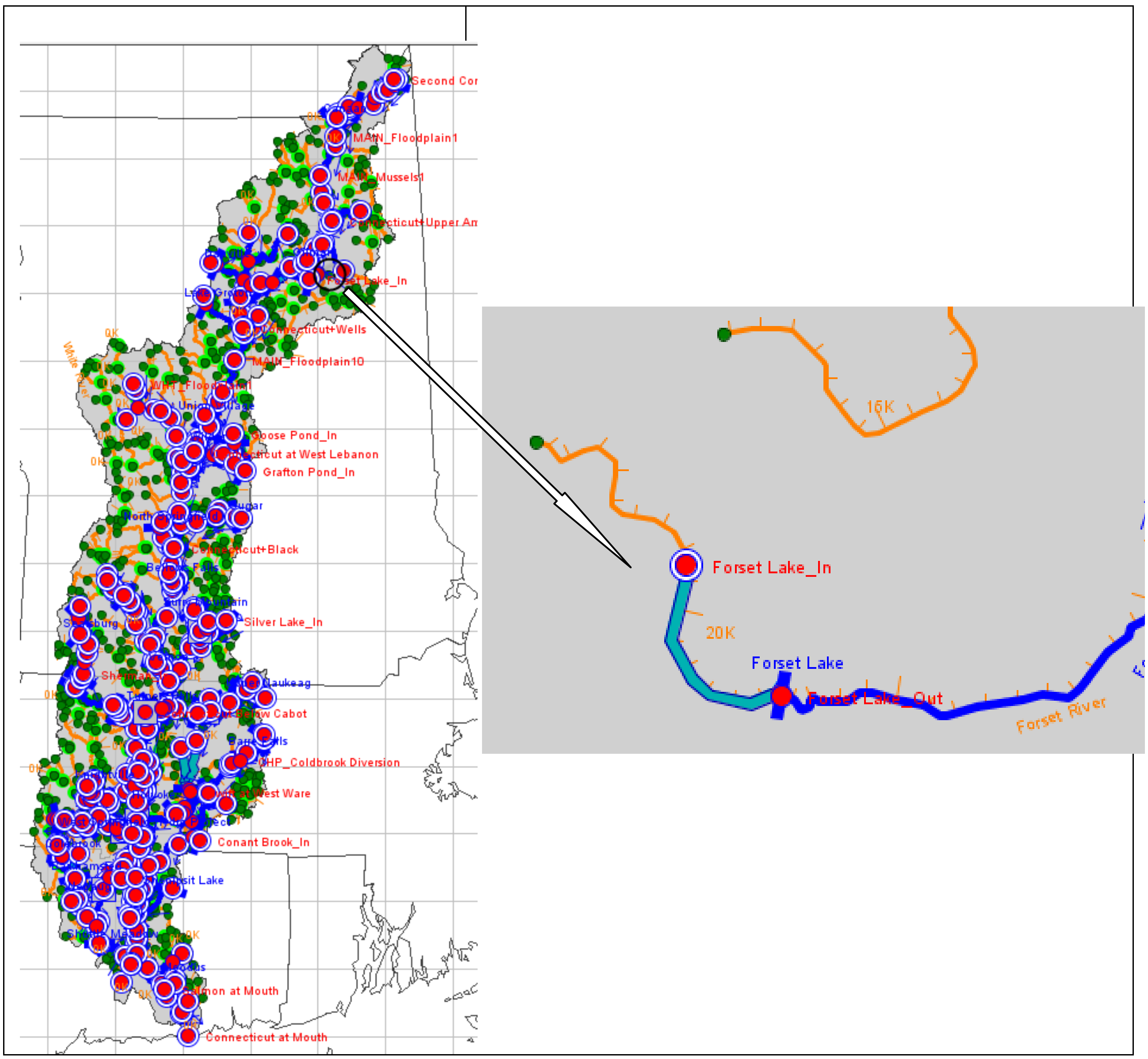


Figure 1: HEC-ResSim Map Display Showing Location of Forest Lake Dam

Figure 2: Photo of Forest Lake reservoir.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[38]. The dam consists of two types of outlets: (1) an uncontrolled concrete spillway, and (2) an uncontrolled stoplog bay as shown in Figure 4.

[38] National Dam Safety Program. Forest Lake Dam Operation & Maintenance Plan. 2007.

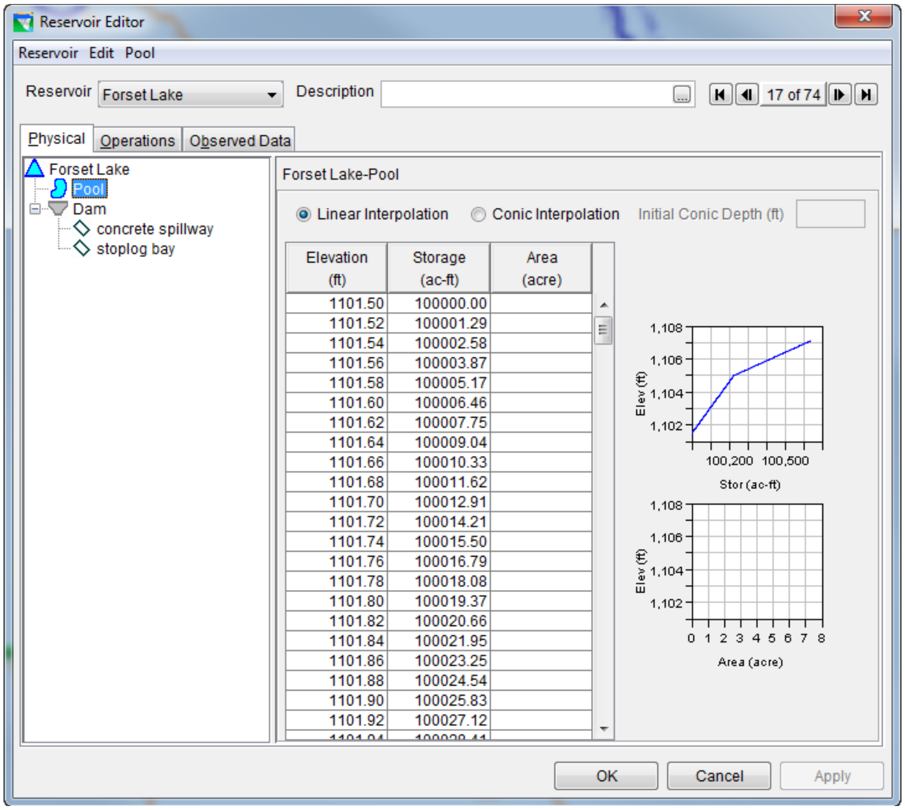


Figure 3: Reservoir Editor: Physical Tab -- Pool

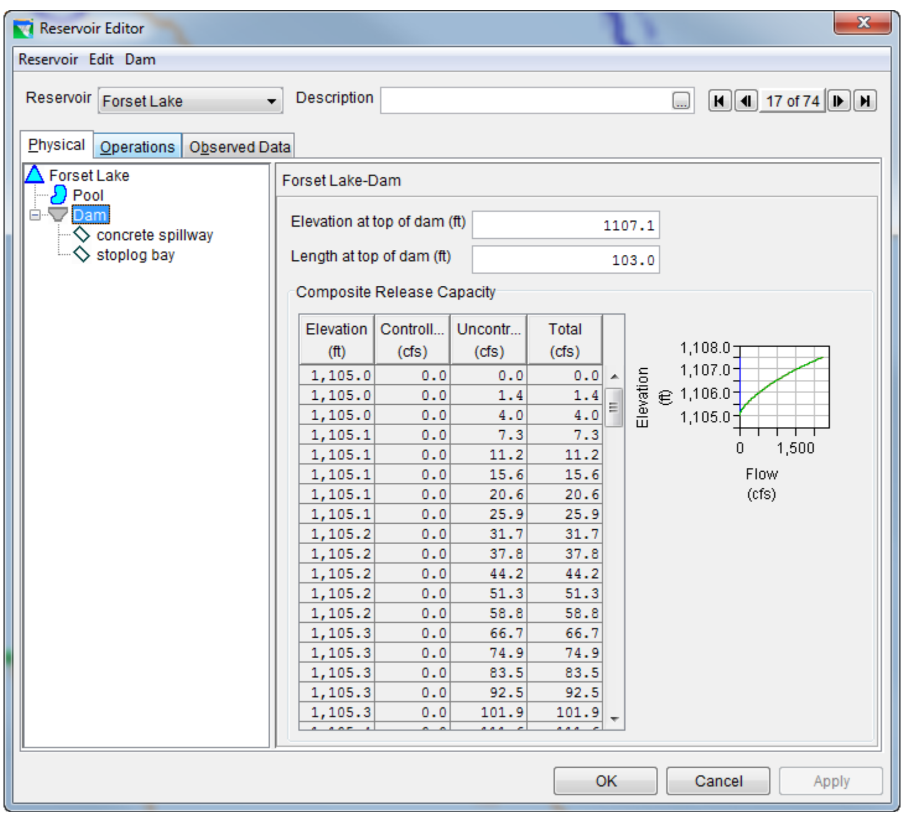


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Forest Lake Dam's "Guide Curve" operational zones, which consist of zones of Top of Dam (1107.1 ft), Conservation (1105 ft), and Inactive zone (1102 ft)[1].

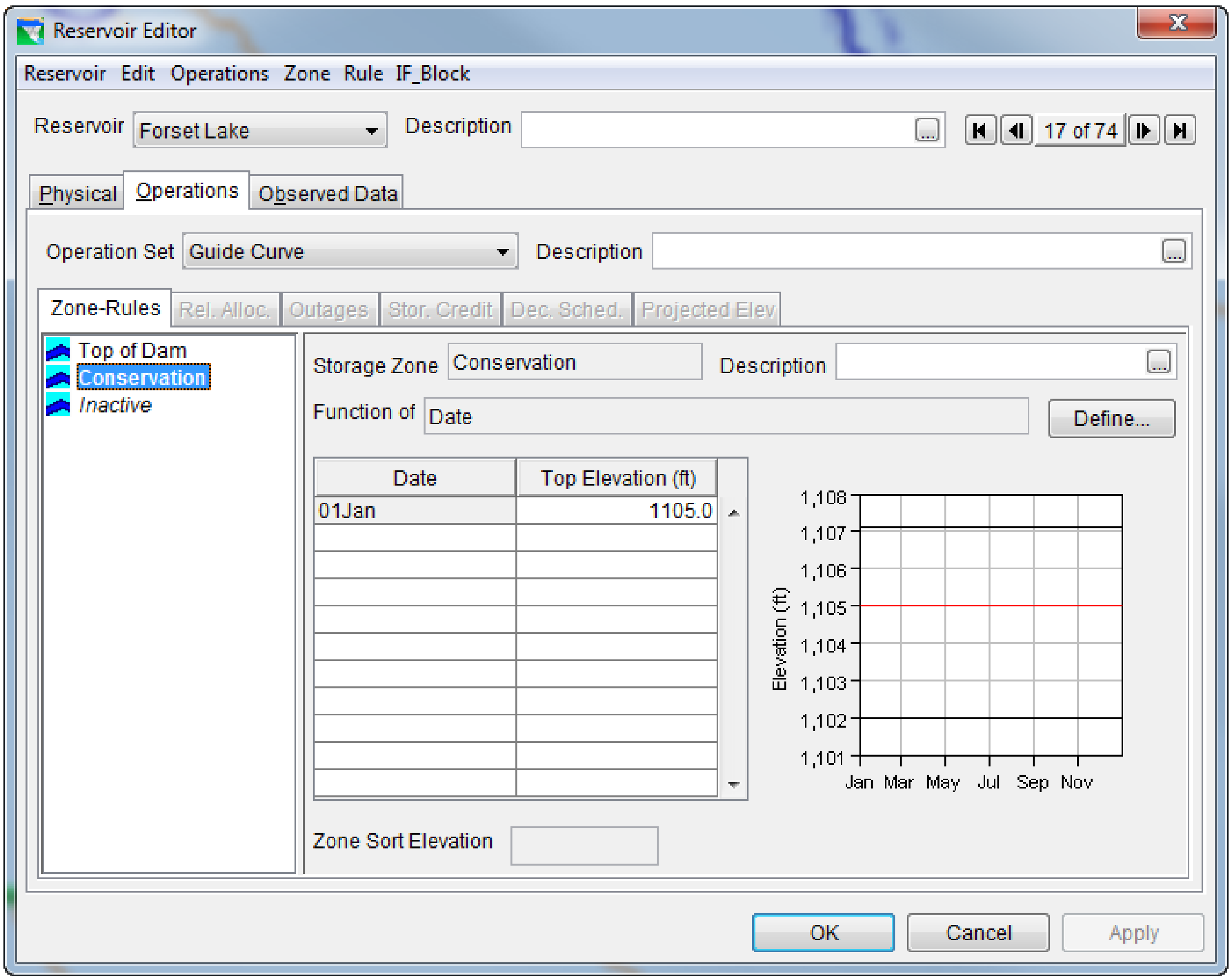


Figure 5 Reservoir Editor: Operations Tab – Guide Curve OpSet

B. Rule Illustrations

The operation set for Forest Lake Dam has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Gardner Falls

I. Overview

Gardner Falls dam is located in Shelburne Falls, MA on the Deerfield River. It is owned and operated by Consolidated Edison and is operated as a run-of-river hydropower generating facility.

Figure 1 shows the location of Gardner Falls dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Gardner Falls dam.

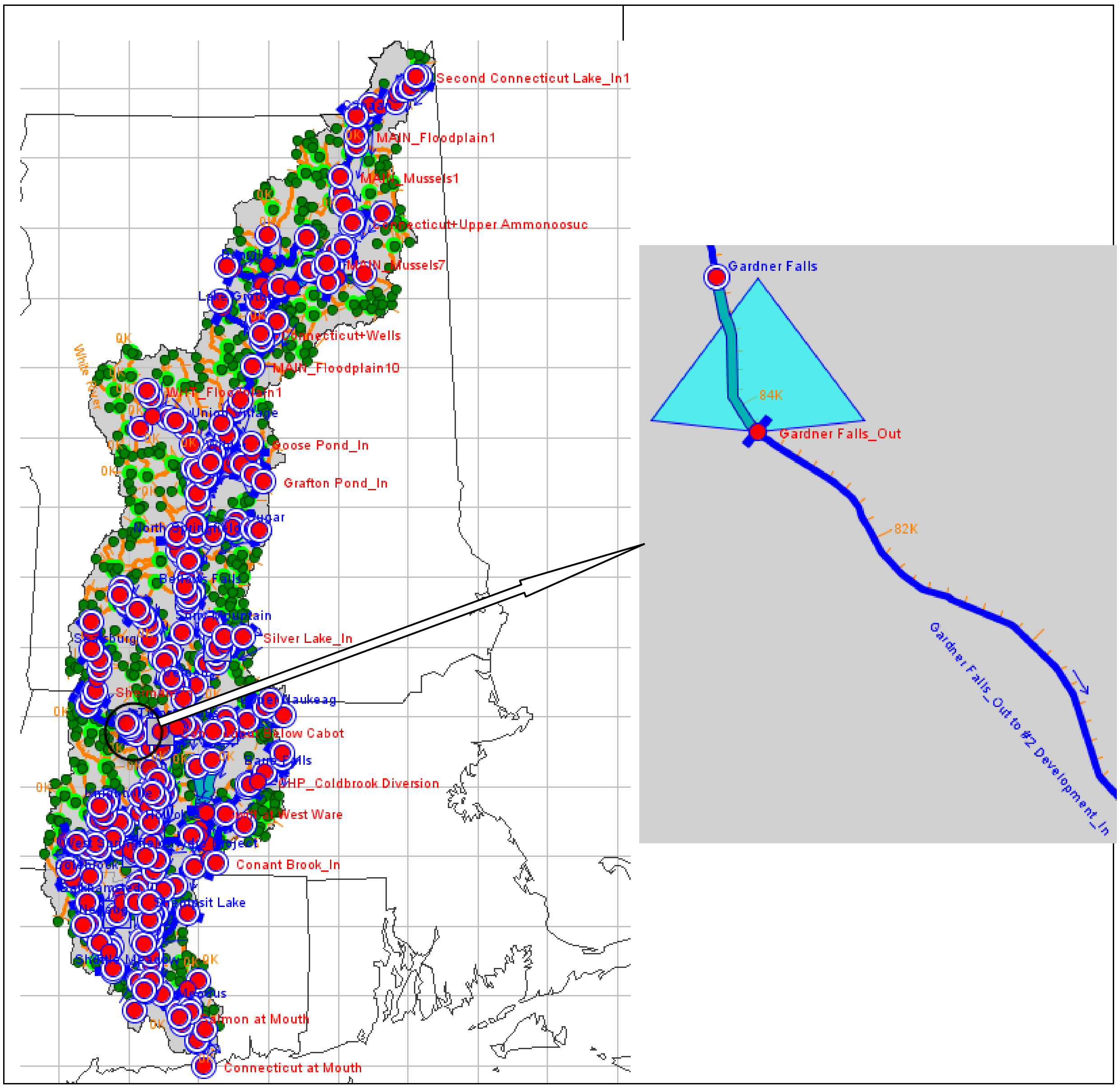


Figure 1: HEC-ResSim Map Display Showing Location of Gardner Falls Dam

Figure 2: Photo of Gardner Falls dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[39]. The dam consists of two types of outlets: (1) uncontrolled outlet and (3) power plant as shown in Figure 4[1,40]. The capacity of the power plant was made to be the maximum release specified in the NID database so that the dam would modeled completely as run-of-river with some actual physical information.

[39] National Inventory of Dams database (NID)
[40] http://www.lowimpacthydro.org/lihi-certificate-80-ferc-no.-gardner-falls-project-maine.html

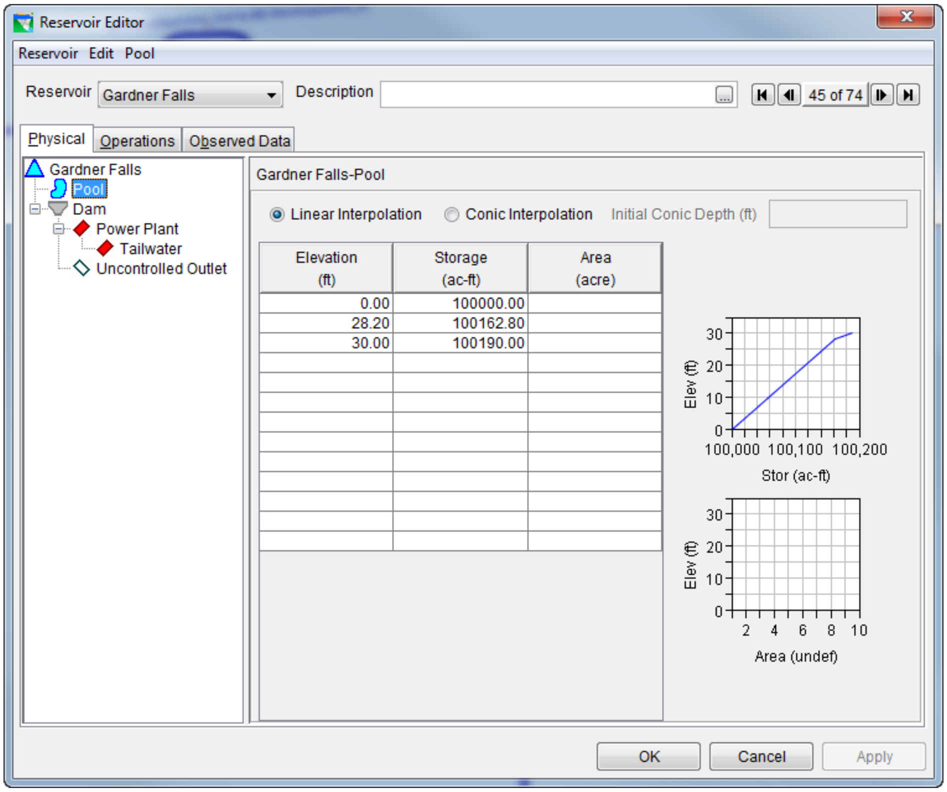


Figure 3: Reservoir Editor: Physical Tab – Pool

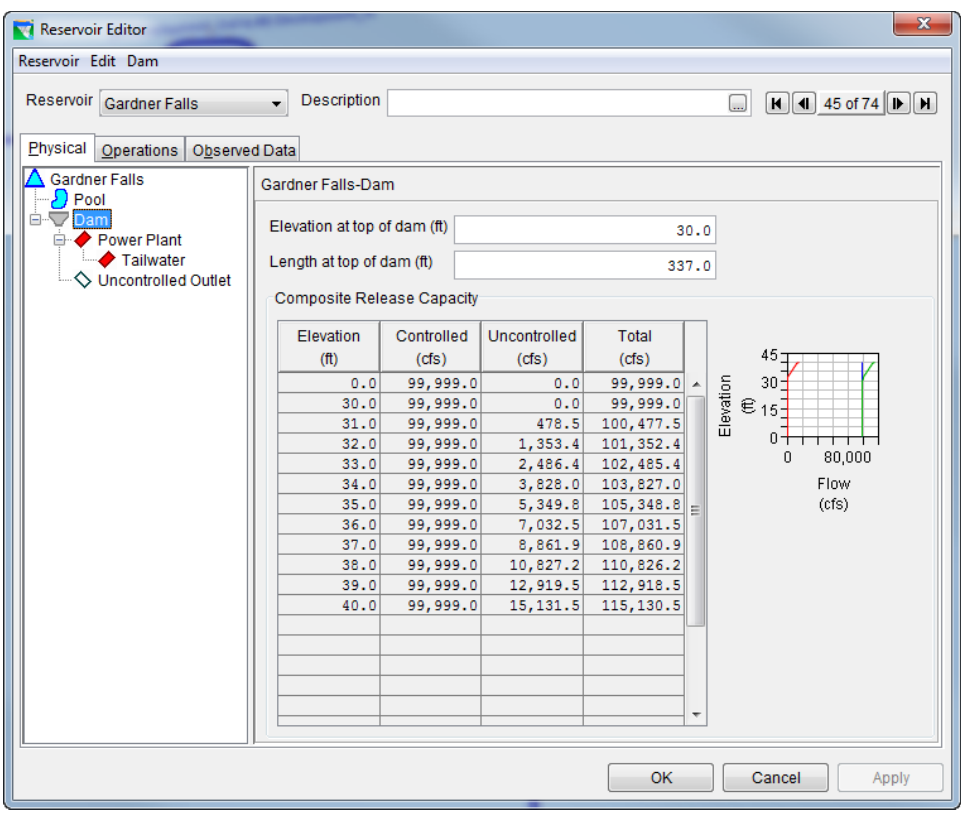


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Gardner Falls's "Guide Curve" operational zones, which consist of Top of Dam (30 ft), Conservation (28.2 ft), and Inactive zone (20 ft)[1]. There was no specified inactive zone so 10 feet below top of dam was arbitrarily chosen.

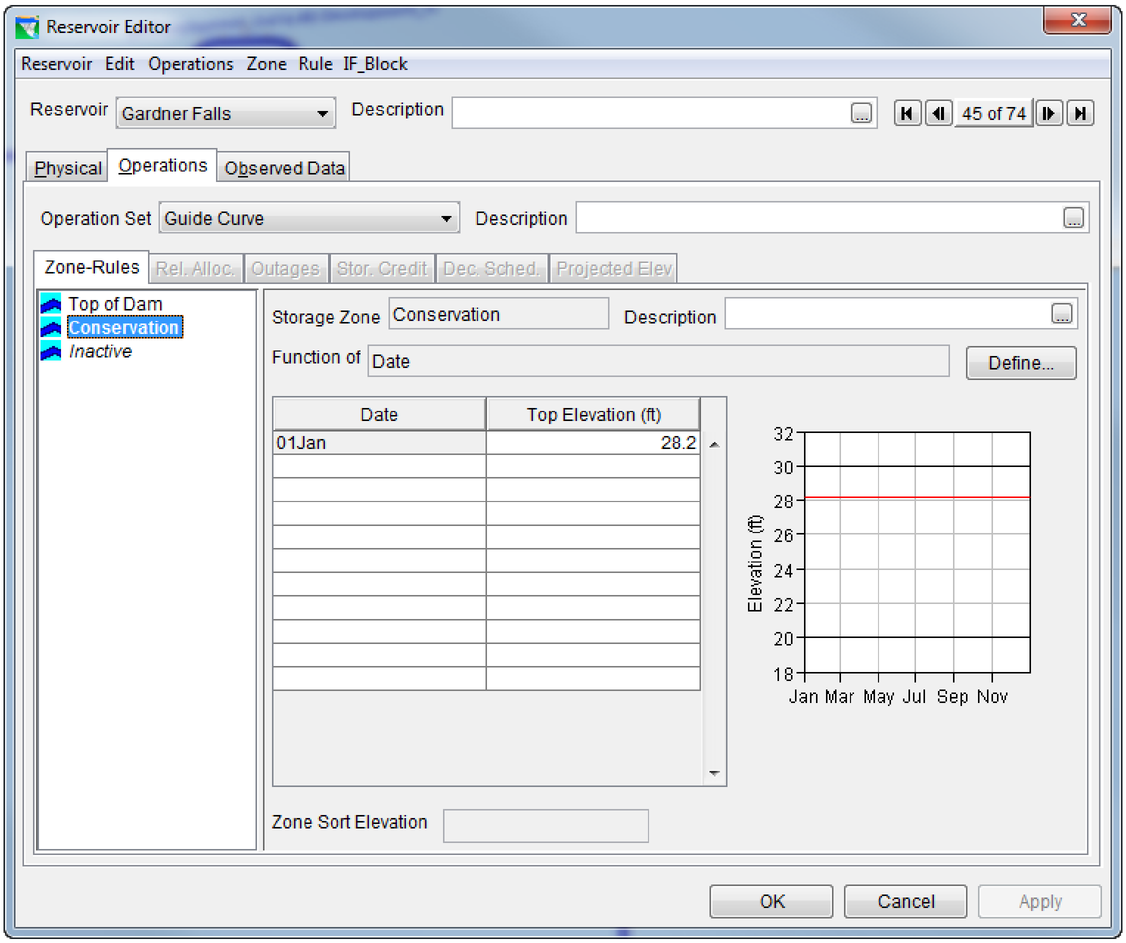


Figure 5: Reservoir Editor: Operations Tab –Guide Curve OpSet – Guide Curve

B. Rule Illustrations

The operation set for Garner Falls has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity. This was modeled this way because no real operation information was found.

Gilman

I. Overview

Gilman dam is located directly downstream of the town of Dalton, NH on the mainstem Connecticut River. It is owned and operated by Ampersand Gilman Hydro LP for run-of-river hydropower generation.

Figure 1 shows the location of Gilman Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo of Gilman Dam.

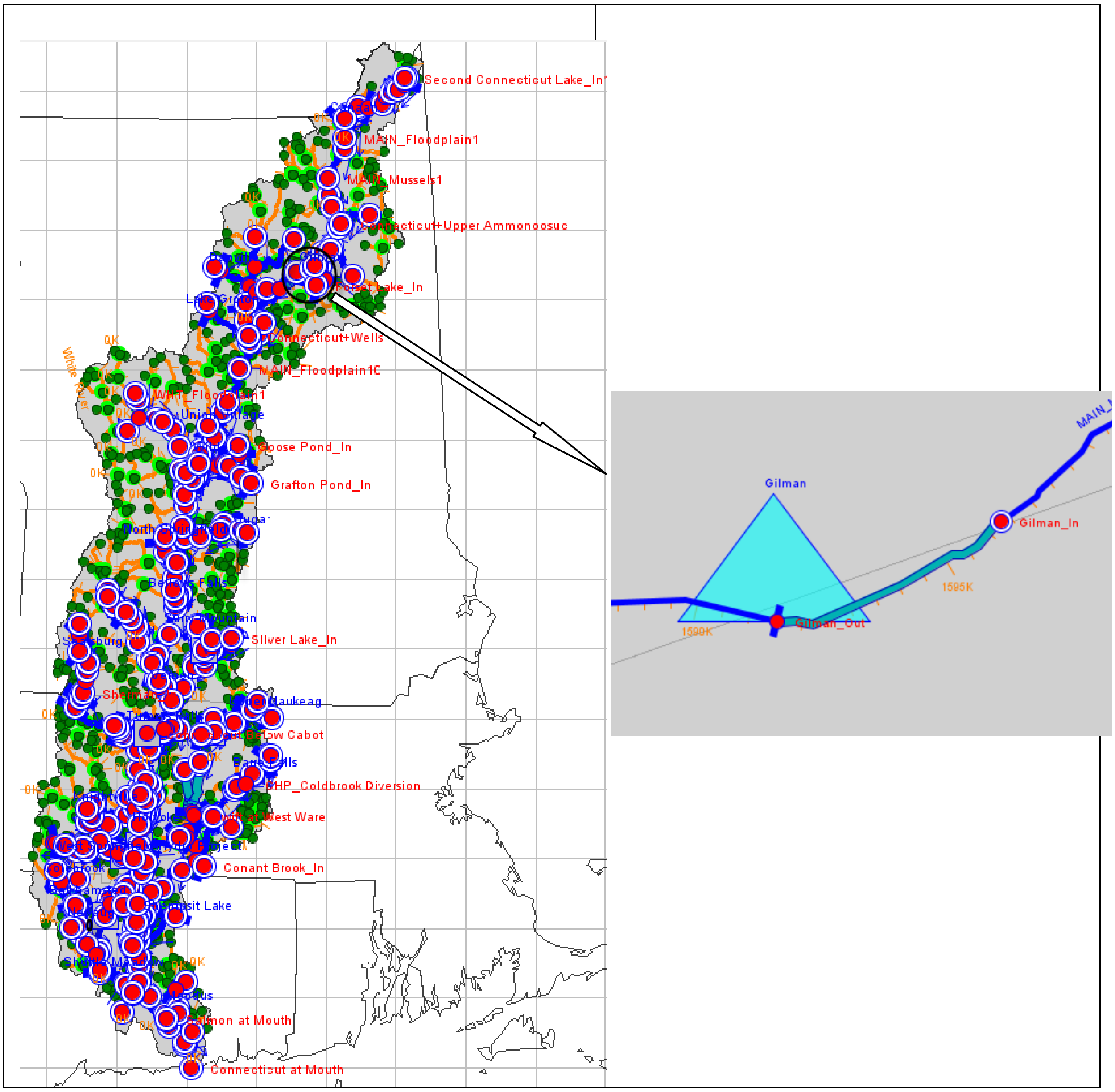


Figure 1: HEC-ResSim Map Display Showing Location of Gilman

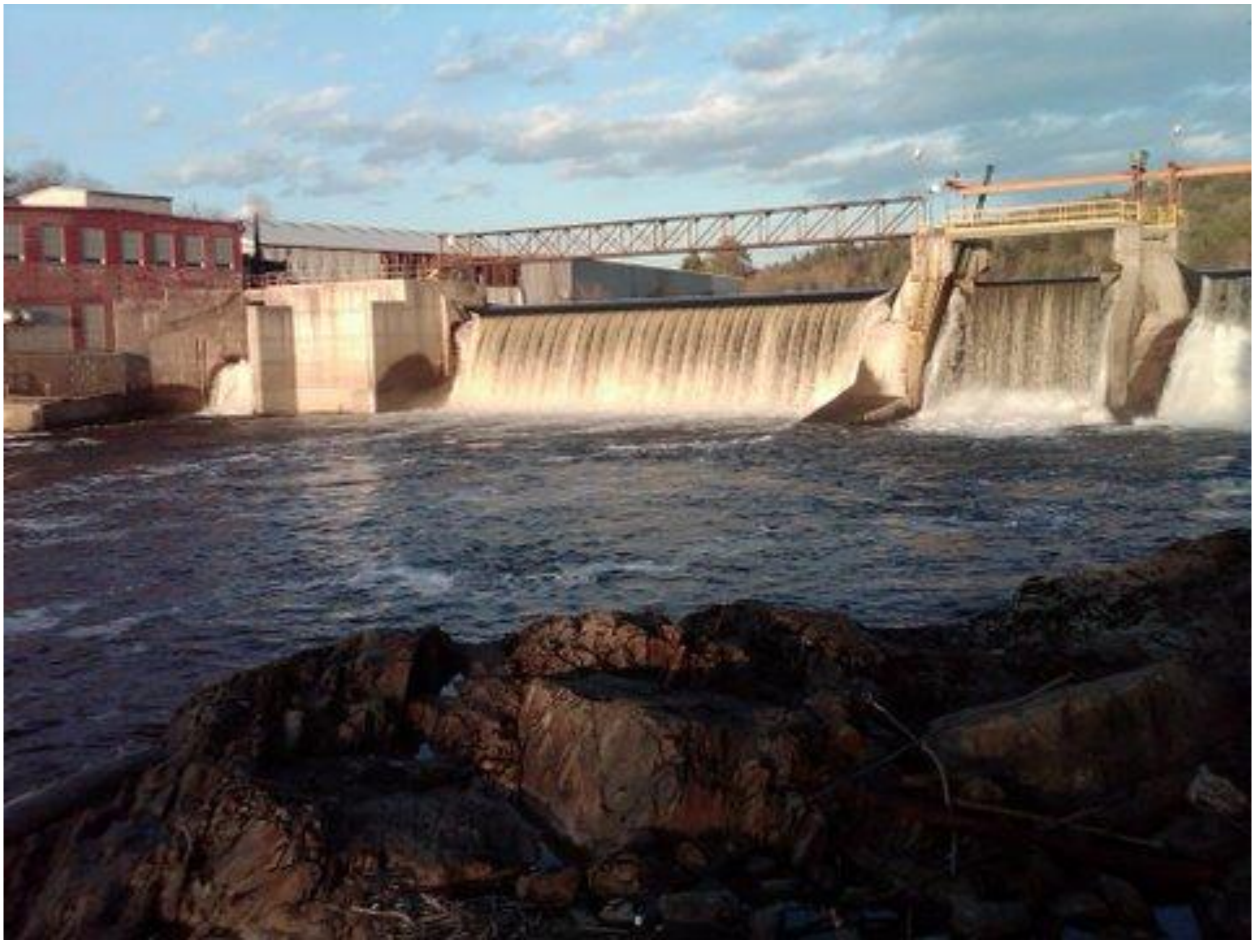


Figure 2: Photo of Gilman Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[41]. The dam consists of two types of outlets: (1) controlled outlet, and (2) power plant as shown in Figure 4.

[41] NHSDam Data Sheet. Gilman. 2009.

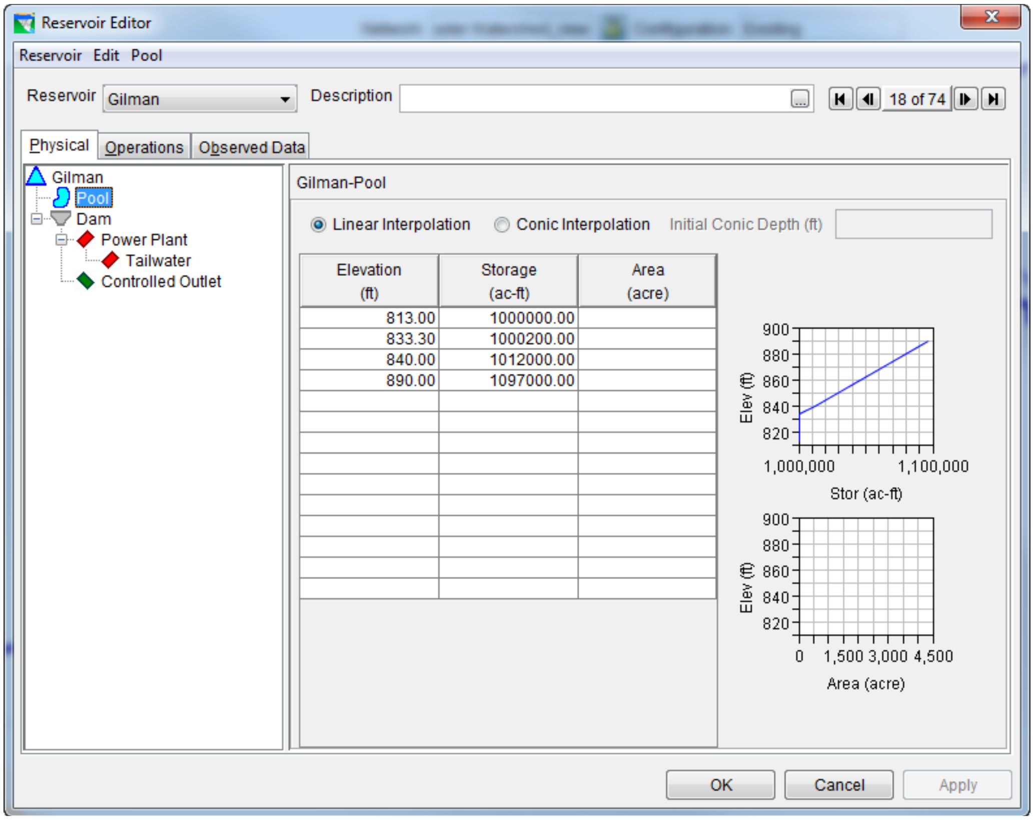


Figure 3: Reservoir Editor: Physical Tab -- Pool

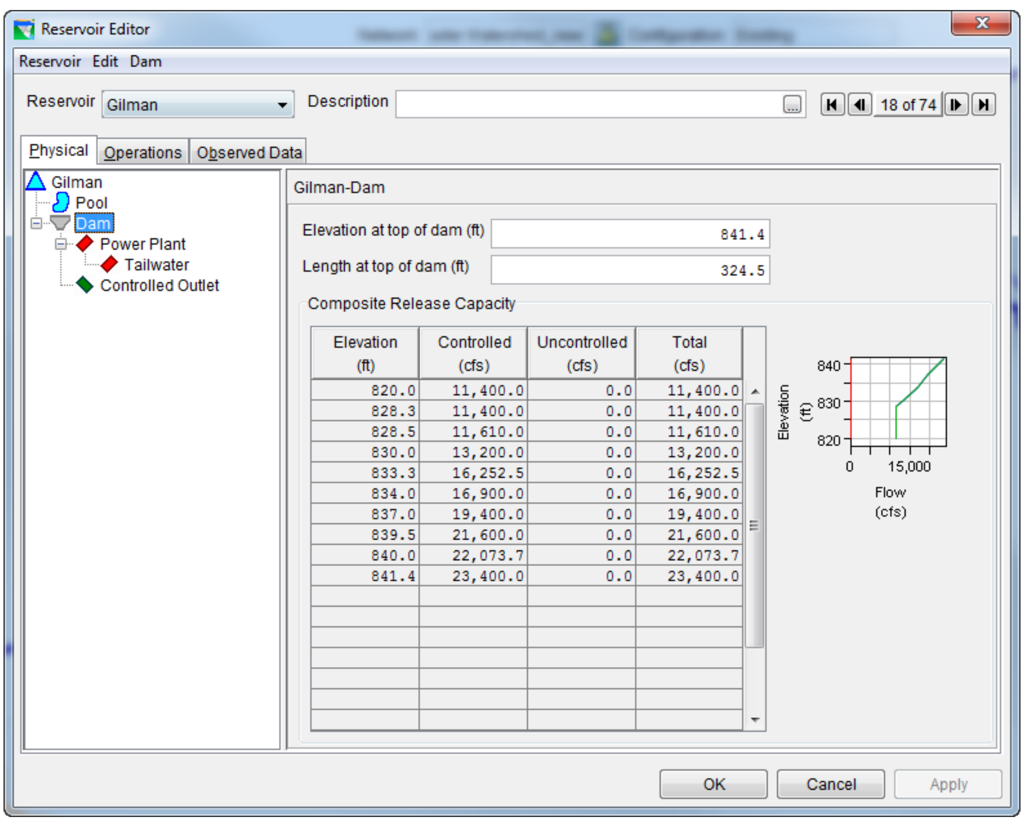


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Gilman's "Existing Ops" operational zones, which consist of zones of Top of dam (850 ft), conservation (833.3 ft), and Inactive zone (814 ft)[42].

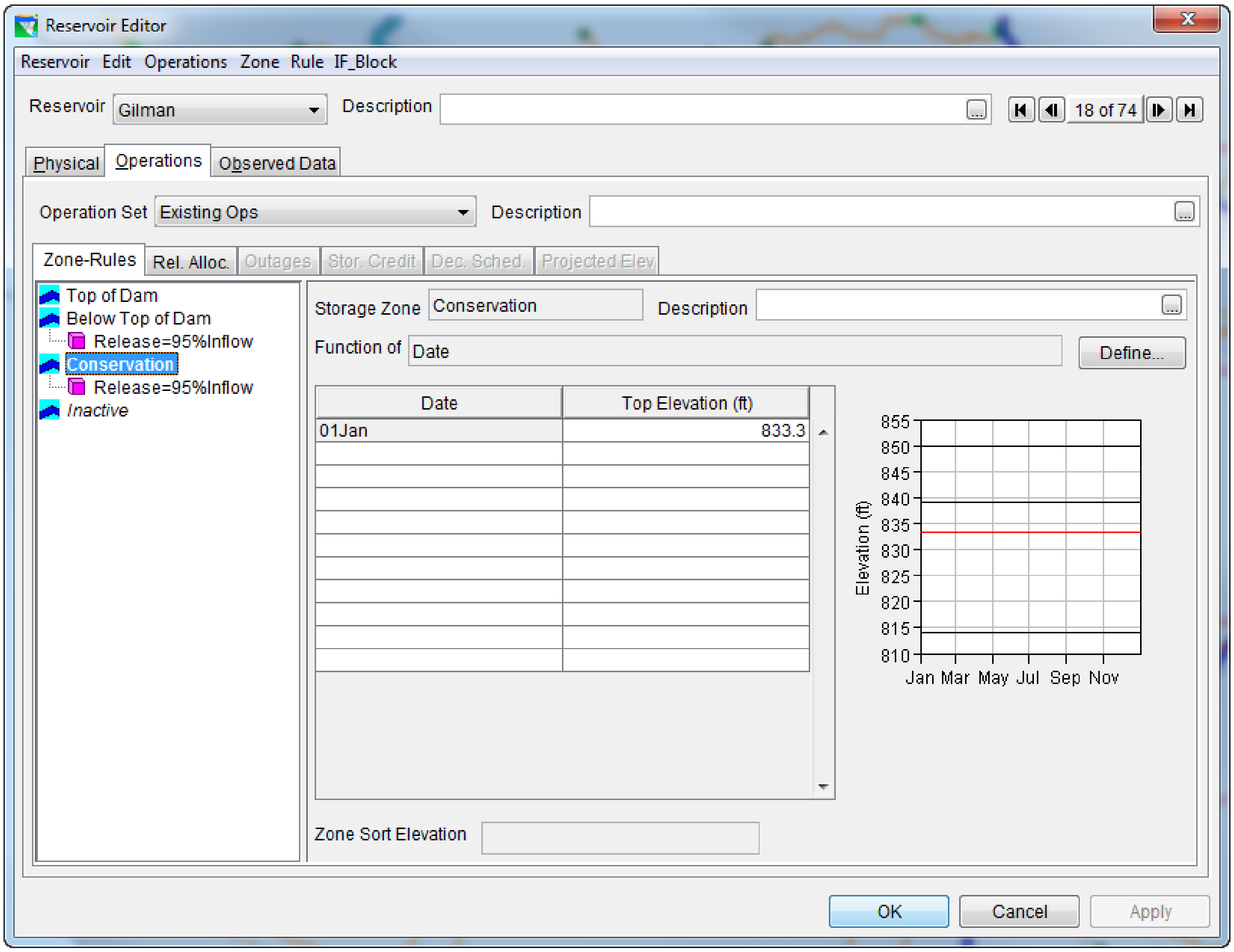


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

[42] Water Quality Certification. 1989.

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

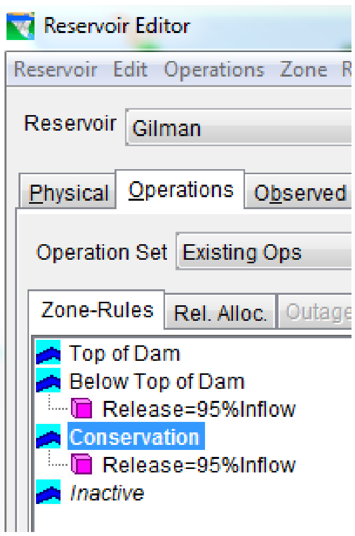


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. *Release=95%Inflow*

Figure 7 shows the content of "Release=95%Inflow" rule. This rule release the minimum of 95% of Inflow from dam as per the run-of-river modeling strategy.

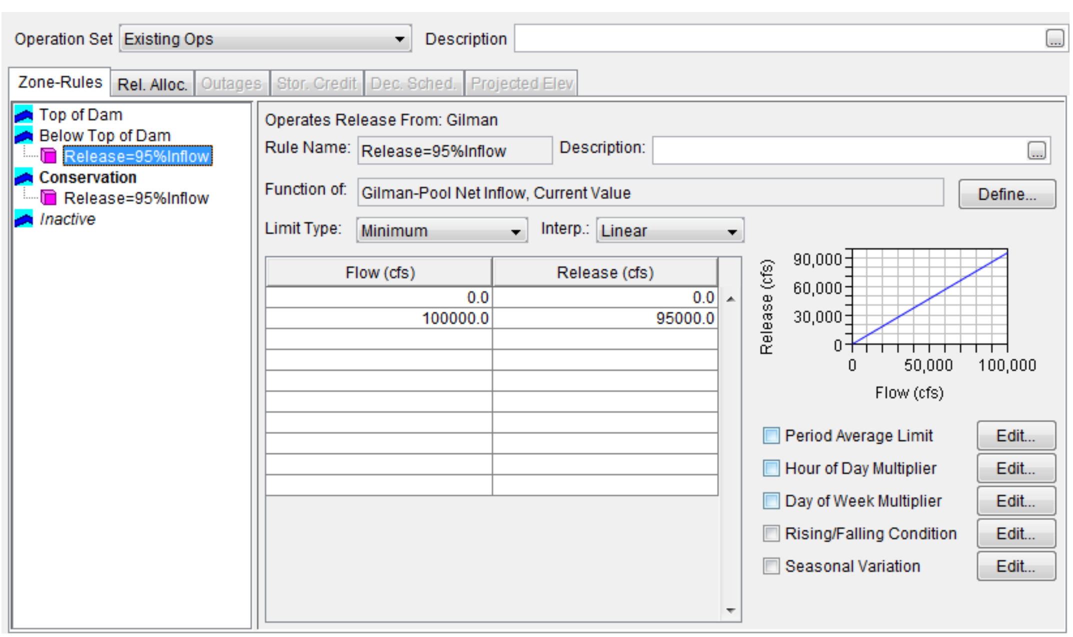


Figure 7 Reservoir Editor: Operations Tab – Existing OpSet – Release=95%Inflow

Goose Pond

I. Overview

Goose Pond dam is a dam located in the town of Canaan and feeds into the Mascoma River. It is owned and operated by the State of New Hampshire and is used to store spring runoff to maintain normal flow on the Mascoma River for hydropower generation by other facilities. It is also used for recreation.

Figure 1 shows the location of Goose Pond Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Goose Pond dam.

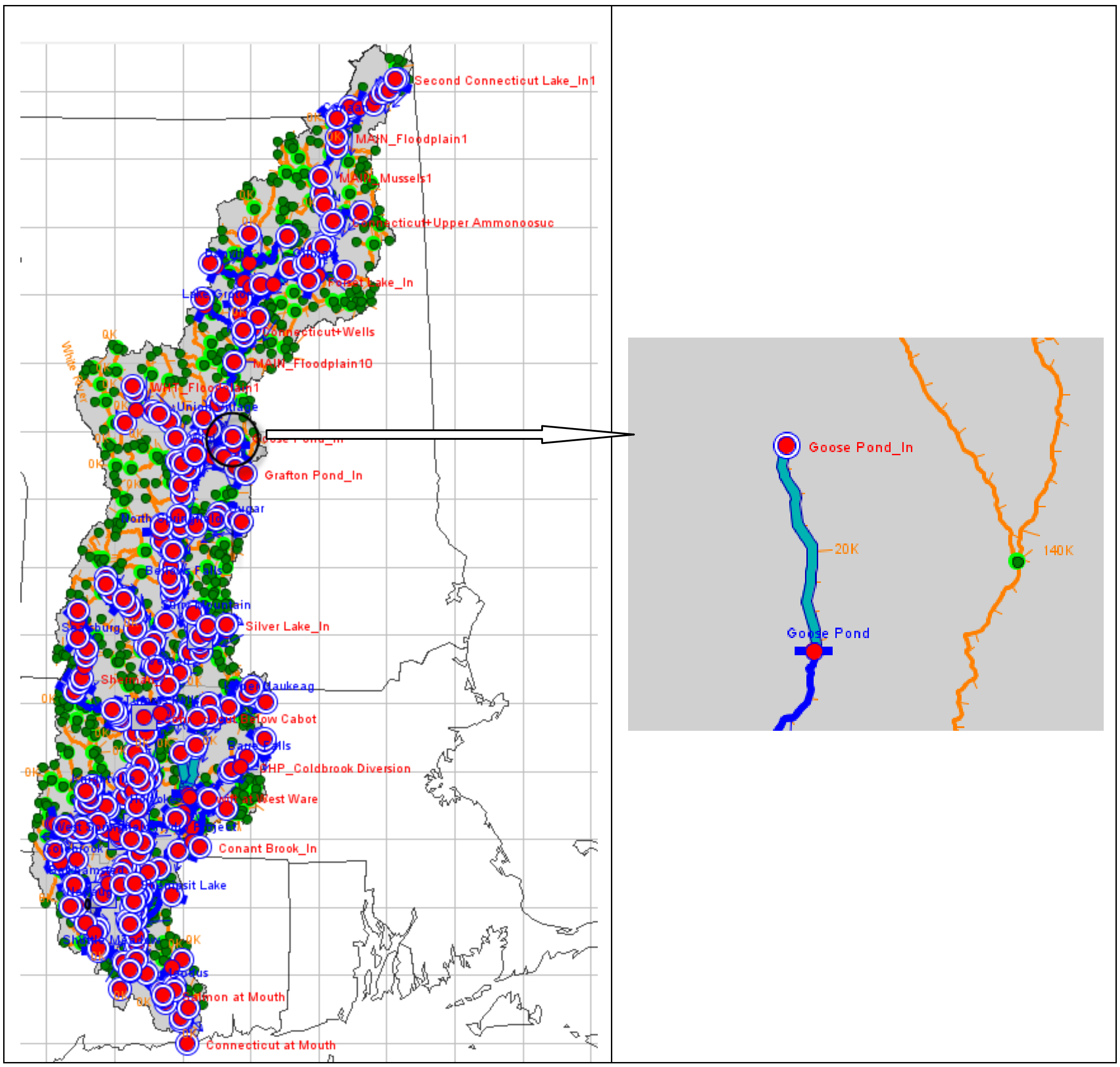


Figure 1: HEC-ResSim Map Display Showing Location of Goose Pond Dam

Figure 2: Photo of Goose Pond dam.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[43]. The dam consists of four types of outlets: (1) controlled slide gates, (2) controlled flashboard gate, (3) uncontrolled broad-crested weir, and (4) controlled slide gates as shown in Figure 4.

[43] National Dam Safety Program. Goose Pond Dam Operation & Maintenance Plan. 2008.

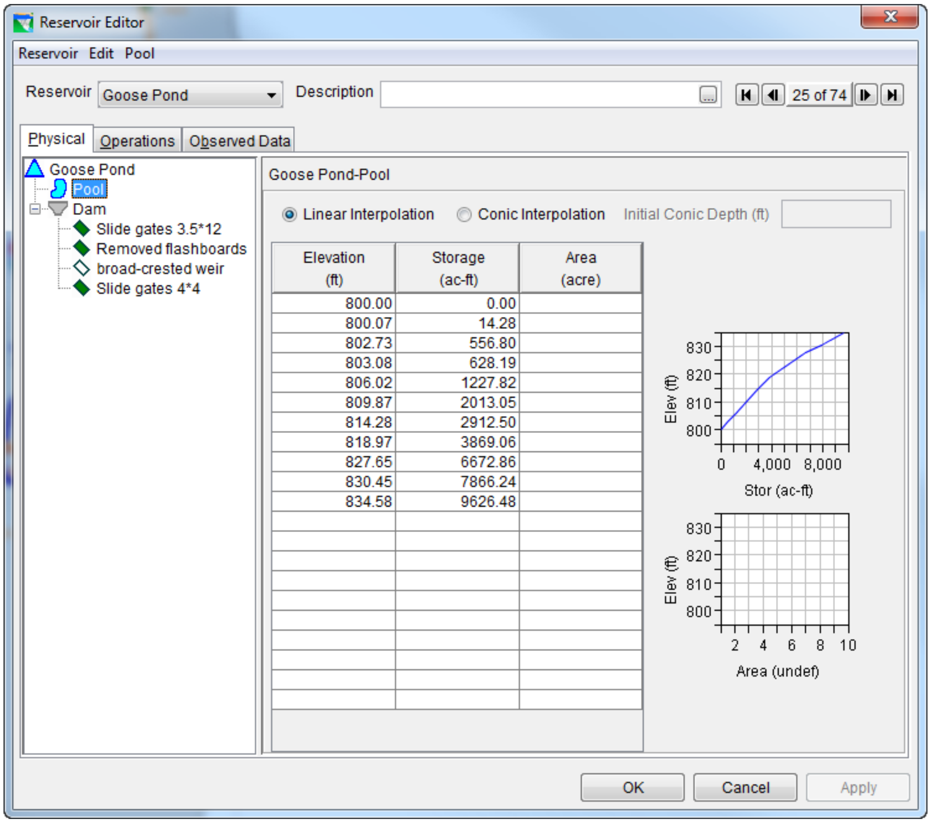


Figure 3: Reservoir Editor: Physical Tab -- Pool

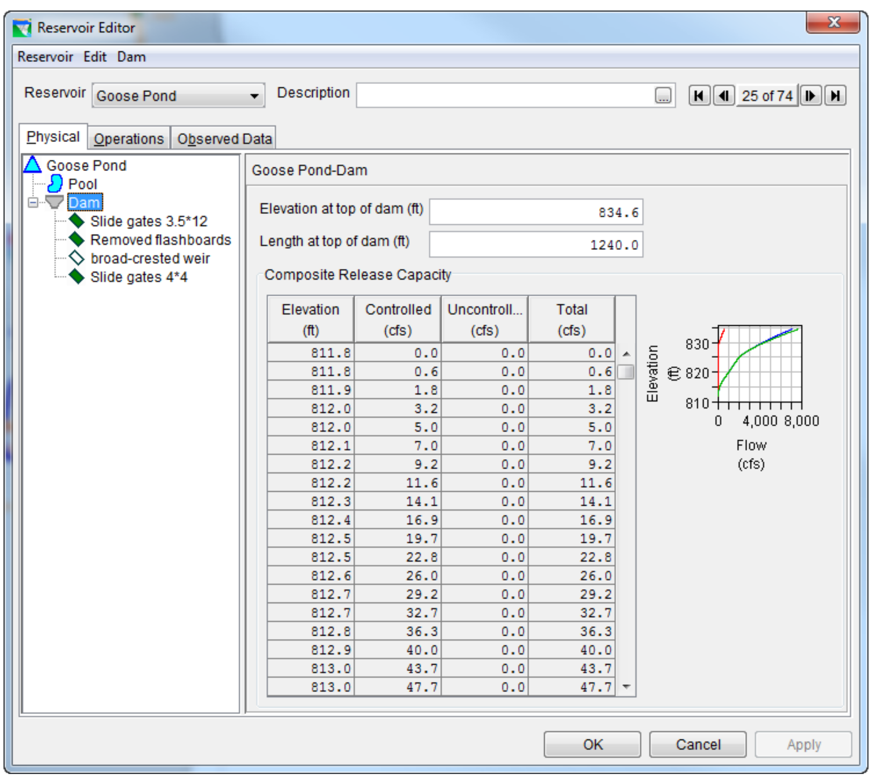


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Goose Pond Dam's "ExistingOps" operational zones, which consist of zones of Top of dam (834.6 ft), Flood Control (833 ft), Conservation (824.4-829 ft), and Inactive zone (803.6 ft)[1].

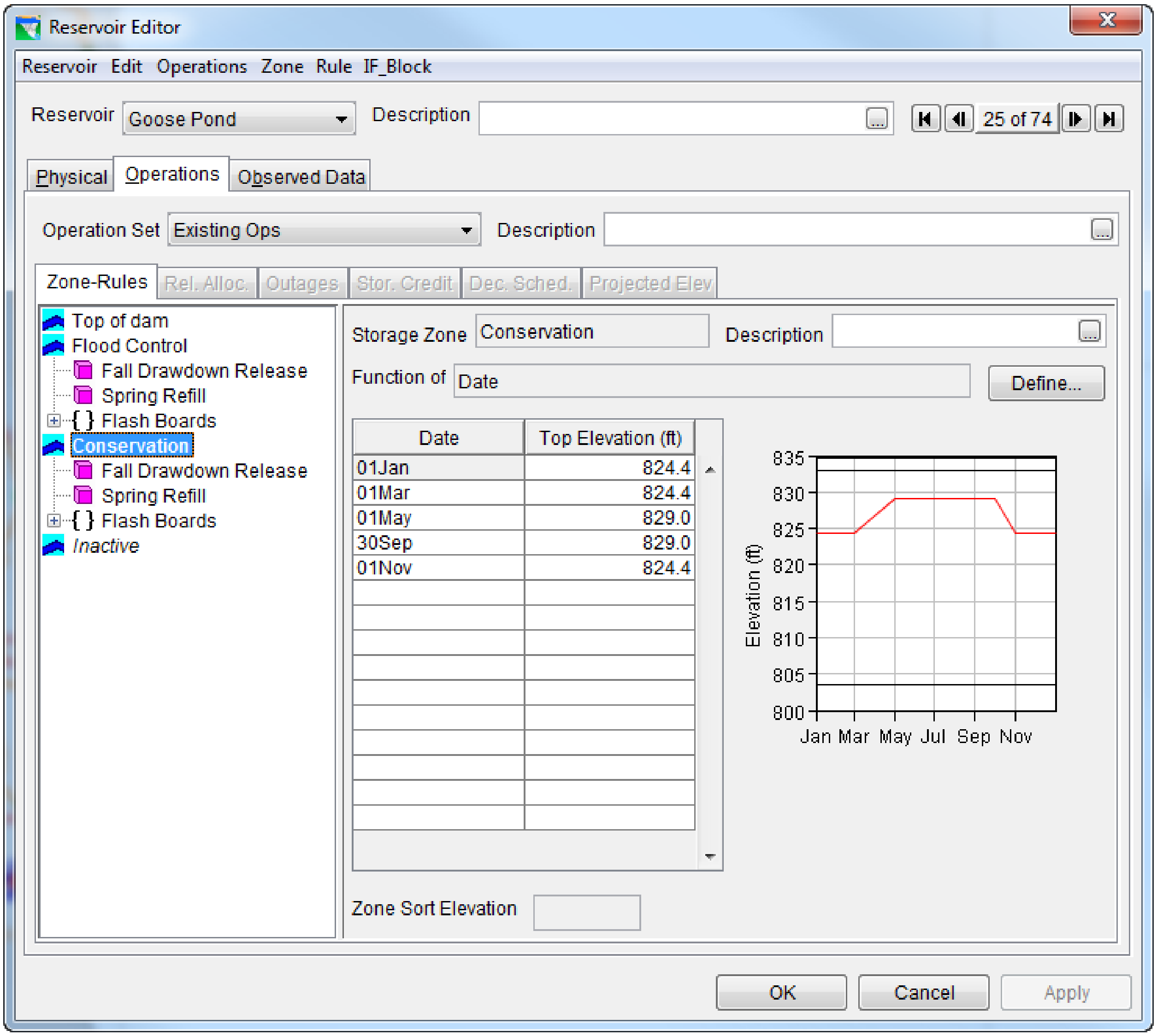


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

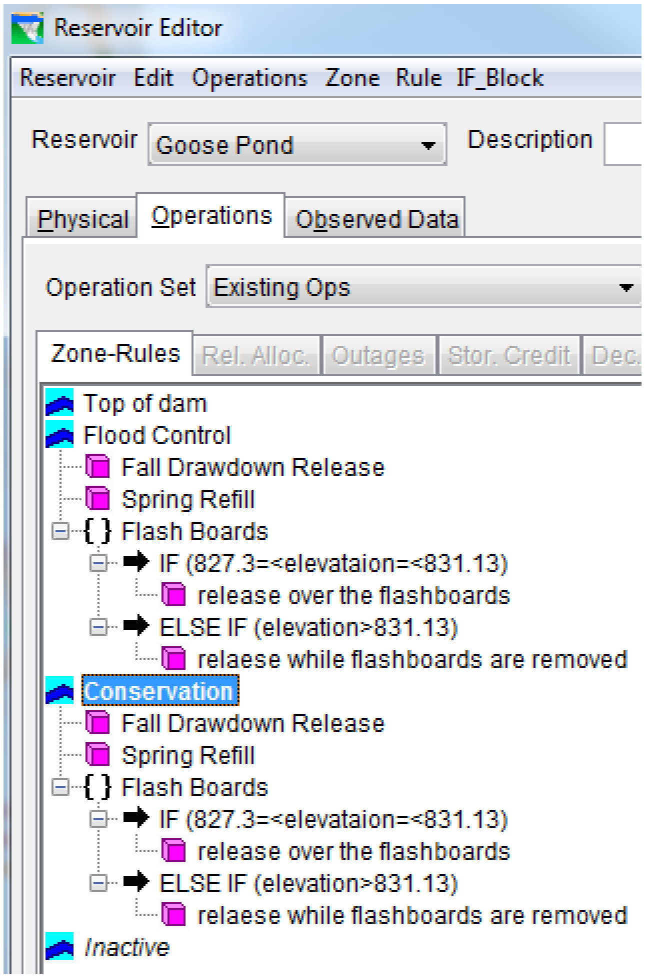
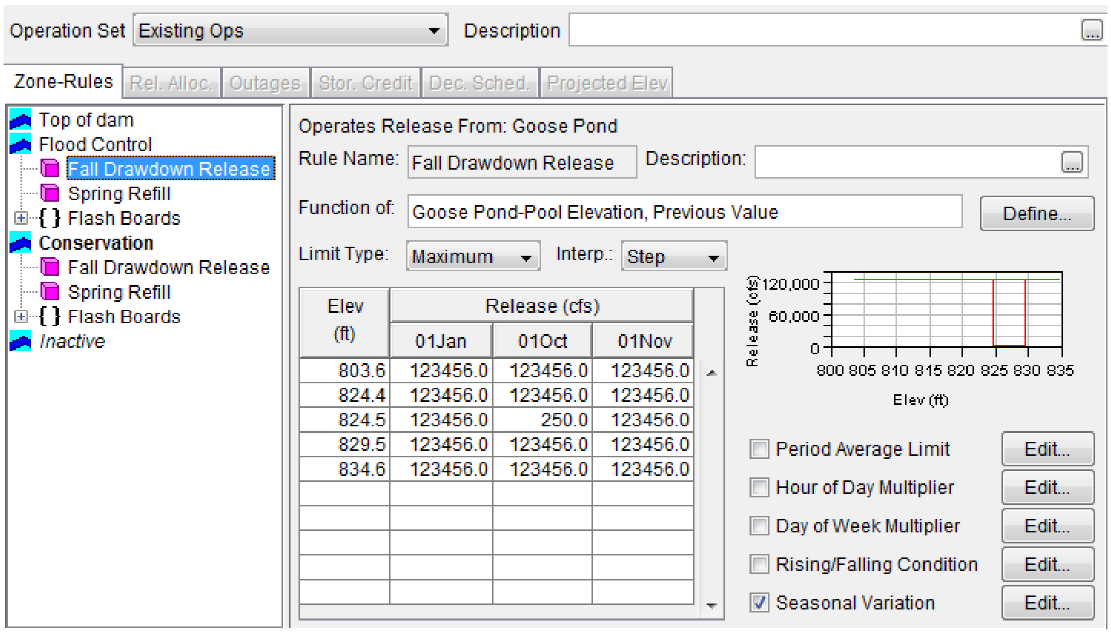


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Fall Drawdown Release

Figure 7 shows the content of "Fall Drawdown Release" rule. This rule defines the maximum release from reservoir as a function of pool elevation.

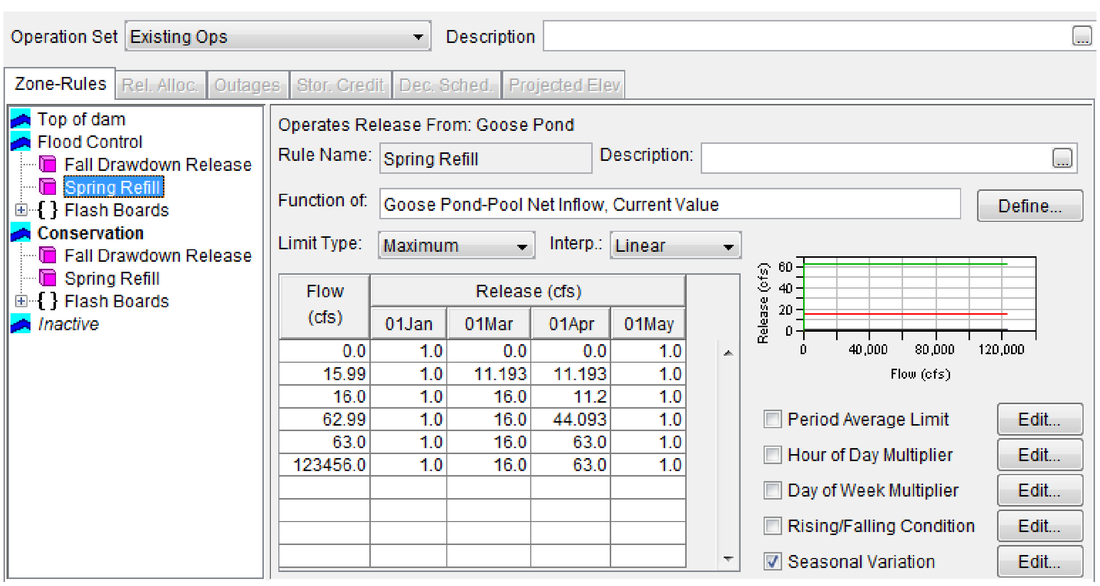


Elev (ft)	Release (cfs) 01Jan	01Oct	01Nov
803.6	123456.0	123456.0	123456.0
824.4	123456.0	123456.0	123456.0
824.5	123456.0	250.0	123456.0
829.5	123456.0	123456.0	123456.0
834.6	123456.0	123456.0	123456.0

Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Fall Drawdown Release

2. Spring Refill

Figure 8 shows the content of "Spring Refill" rule. This rule represents the seasonal maximum release from reservoir as a function of Inflow.

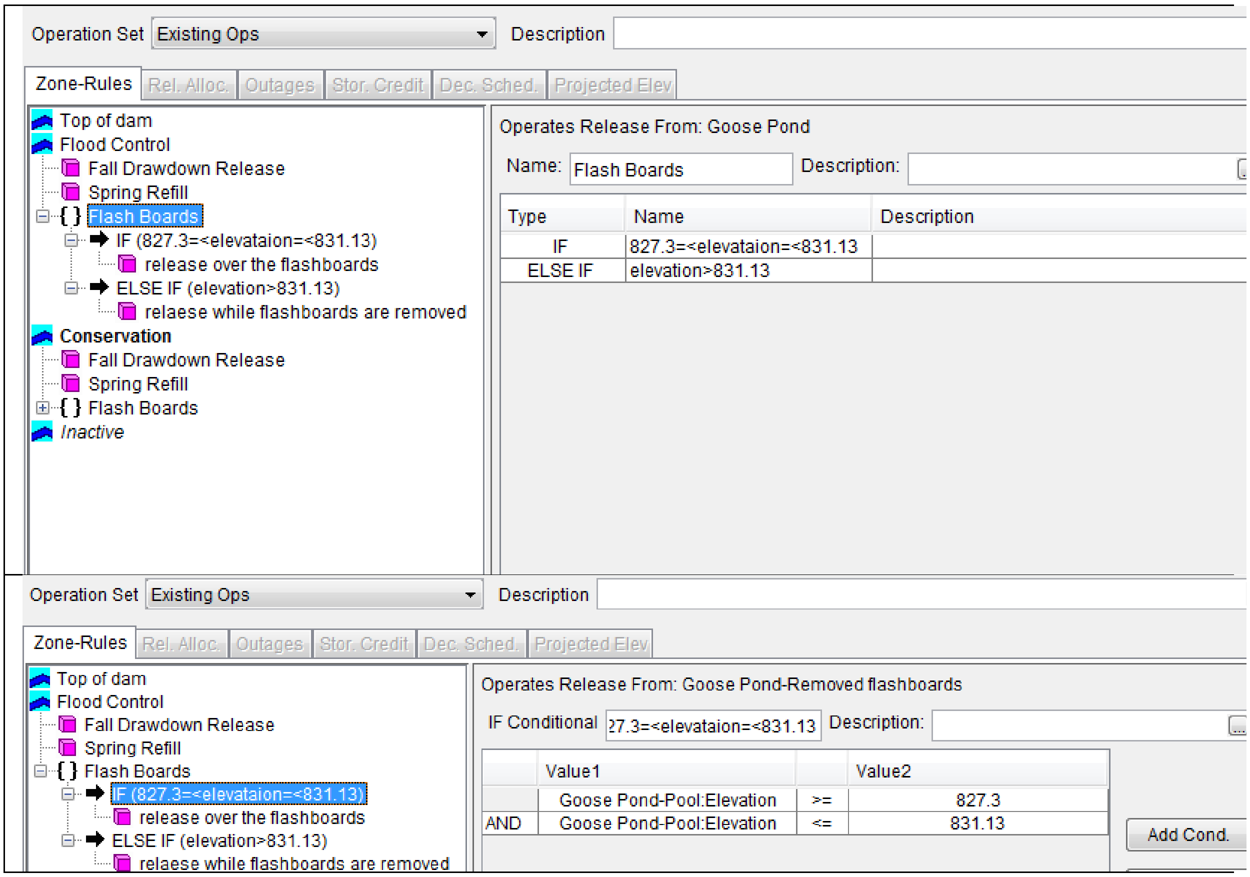


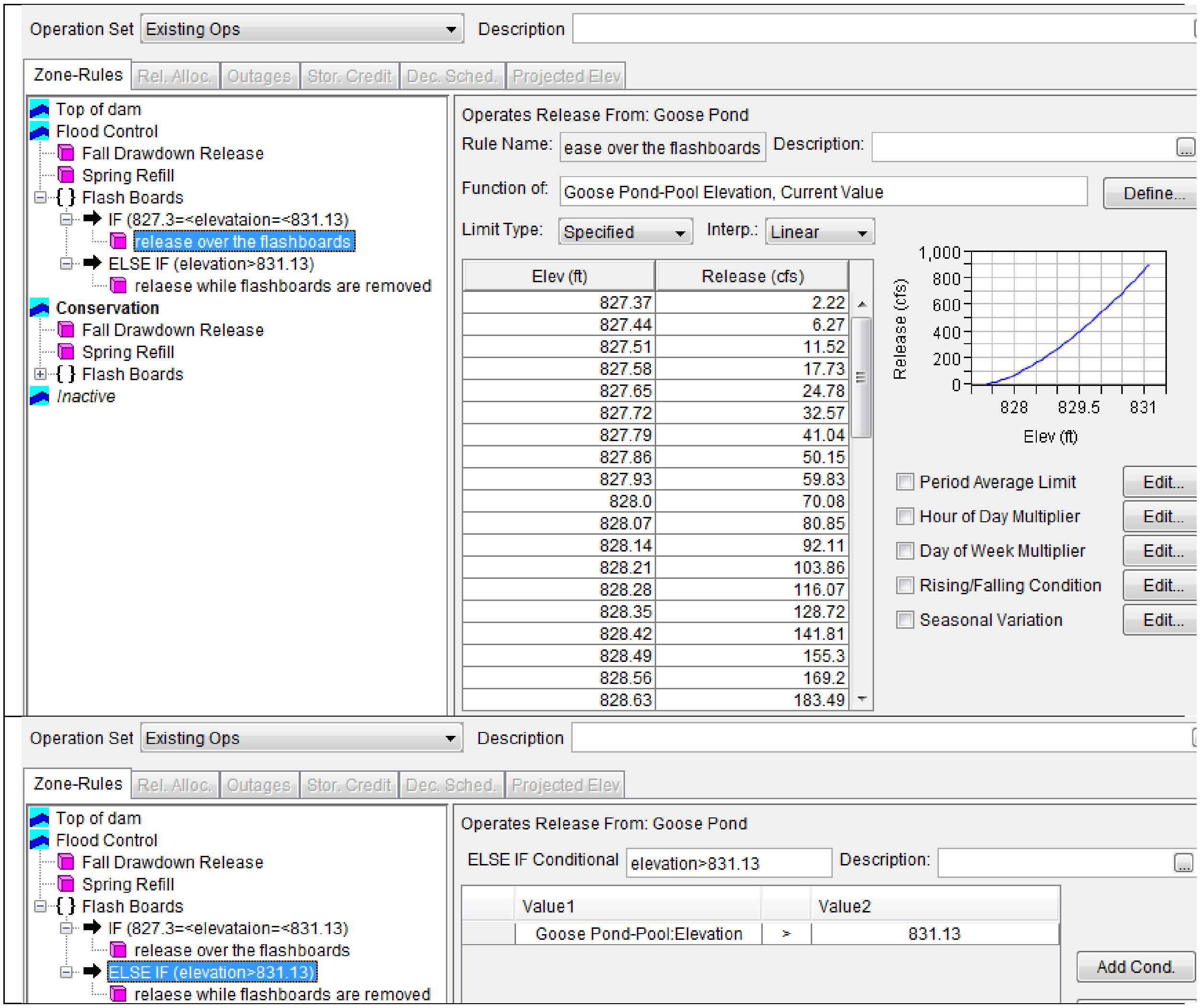
Flow (cfs)	Release (cfs) 01Jan	01Mar	01Apr	01May
0.0	1.0	0.0	0.0	1.0
15.99	1.0	11.193	11.193	1.0
16.0	1.0	16.0	11.2	1.0
62.99	1.0	16.0	44.093	1.0
63.0	1.0	16.0	63.0	1.0
123456.0	1.0	16.0	63.0	1.0

Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Spring Refill

3. *Flash Boards*

Figure 9 shows the content of "Flash Boards" rule. This rule represents the seasonal maximum flow from reservoir based on Inflow.




Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Flood Control
Fall Drawdown Release
Spring Refill
Flash Boards
IF (827.3=<elevataion=<831.13)
release over the flashboards
ELSE IF (elevation>831.13)
relaese while flashboards are removed
Conservation
Fall Drawdown Release
Spring Refill
Flash Boards
Inactive
Operates Release From: Goose Pond
Rule Name:
ease over the flashboards
Description:
Function of:
Goose Pond-Pool Elevation, Current Value
Define...
Limit Type:
Specified
Interp.:
Linear
Elev (ft)
Release (cfs)
827.37 2.22
827.44 6.27
827.51 11.52
827.58 17.73
827.65 24.78
827.72 32.57
827.79 41.04
827.86 50.15
827.93 59.83
828.0 70.08
828.07 80.85
828.14 92.11
828.21 103.86
828.28 116.07
828.35 128.72
828.42 141.81
828.49 155.3
828.56 169.2
828.63 183.49
1,000
800
600
400
200
0
Release (cfs)
828
829.5
831
Elev (ft)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...
Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Flood Control
Fall Drawdown Release
Spring Refill
Flash Boards
IF (827.3=<elevataion=<831.13)
release over the flashboards
ELSE IF (elevation>831.13)
relaese while flashboards are removed
Operates Release From: Goose Pond
ELSE IF Conditional
elevation>831.13
Description:
Value1
Value2
Goose Pond-Pool:Elevation
>
831.13
Add Cond.

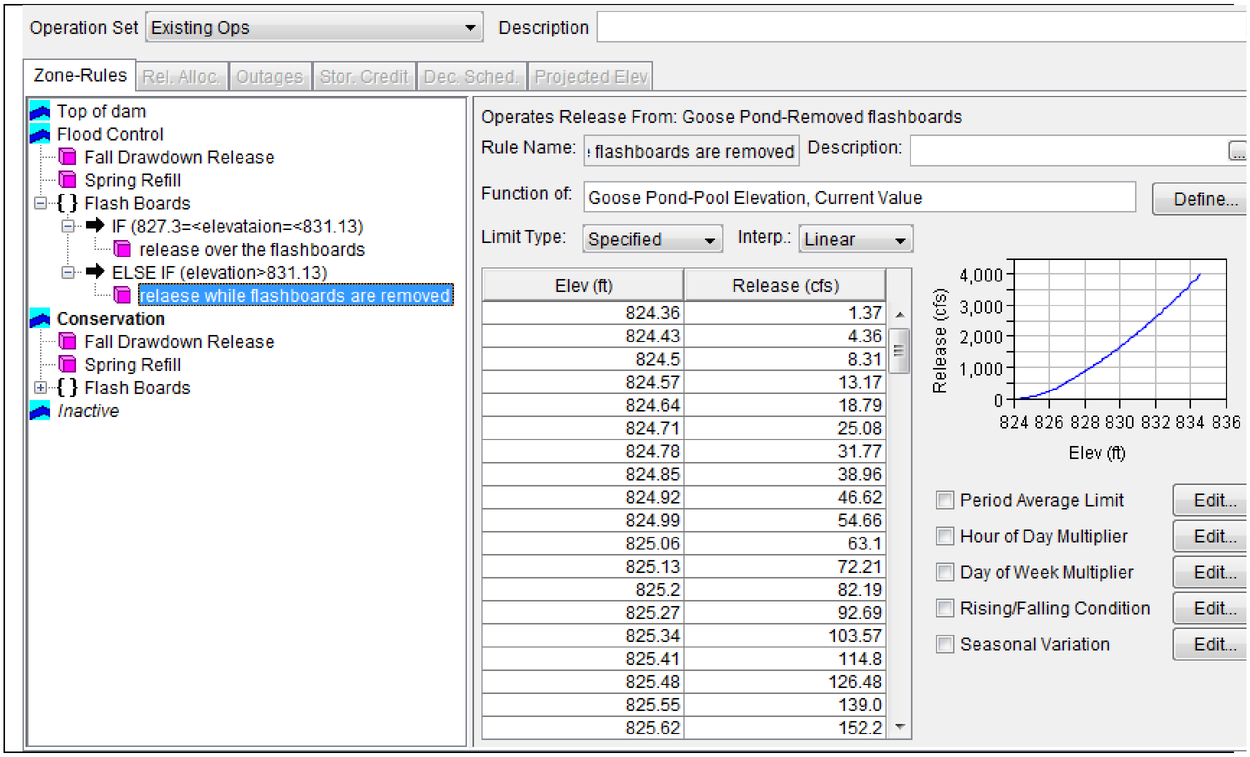


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Flash Boards

Grafton Pond

I. Overview

The Grafton Pond Dam lies on a tributary of the Mascoma River close to Enfield Center, NH. The dam is owned and operated by the New Hampshire Water Resources Board. It is primarily used to maintain the level of Grafton Pond for recreation but also has some flood control benefits.

Figure 1 shows the location of Grafton Pond as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Grafton Pond dam.

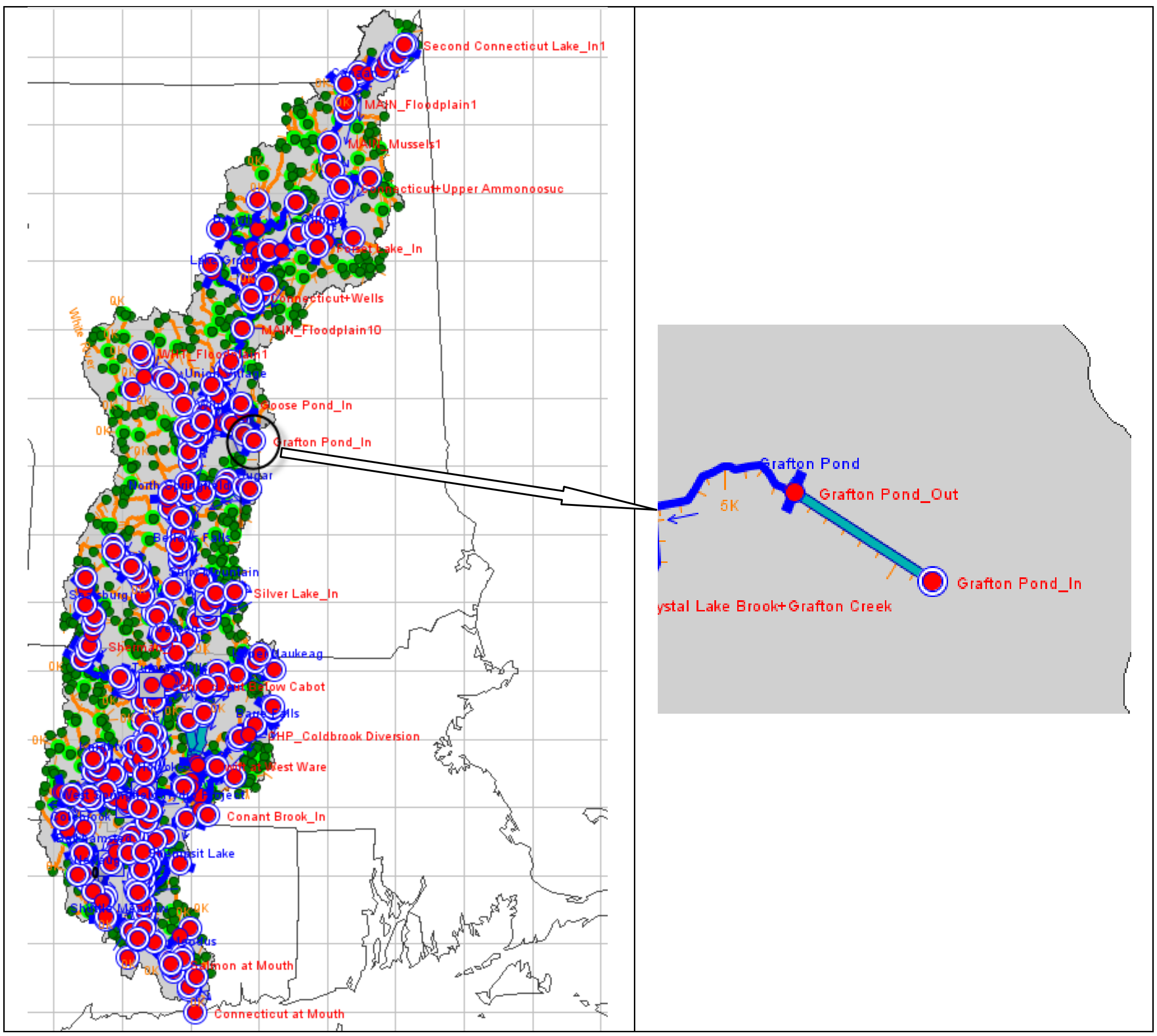


Figure 1: HEC-ResSim Map Display Showing Location of Grafton Pond

Figure 2: Photo of Grafton Pond dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[44]. The dam consists of three types of outlets: (1) controlled slide gates, (2) uncontrolled spillway-over TOD, and (3) uncontrolled lower spillway as shown in Figure 4[45].

[44] NHDam Data Sheet. Grafton Pond. 2009.
[45] National Dam Safety Program. Grafton Pond Operation and Maintenance Plan. 1978.

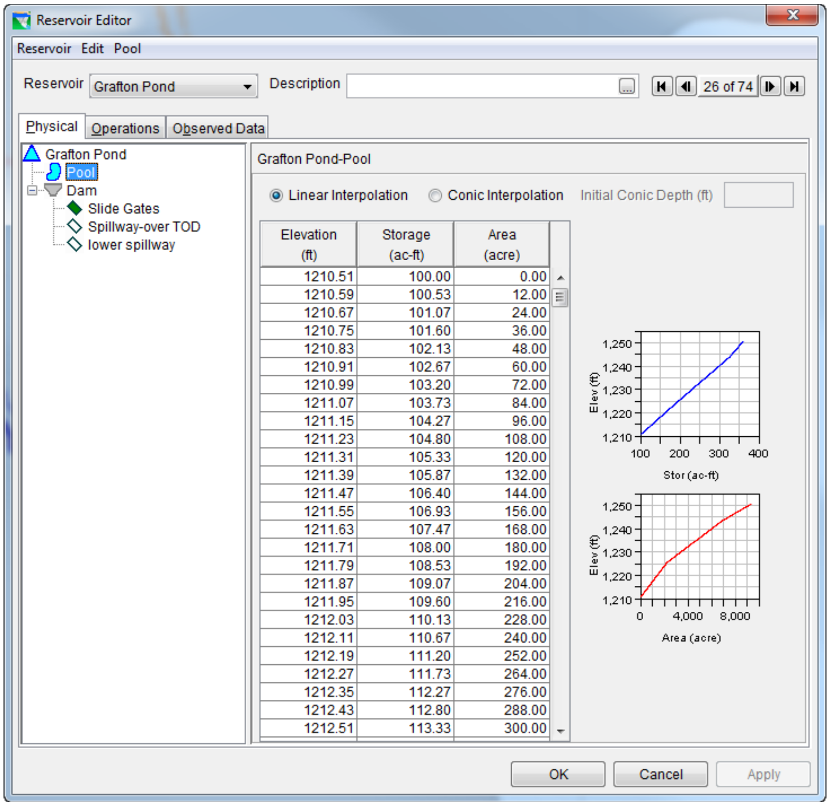


Figure 3: Reservoir Editor: Physical Tab -- Pool

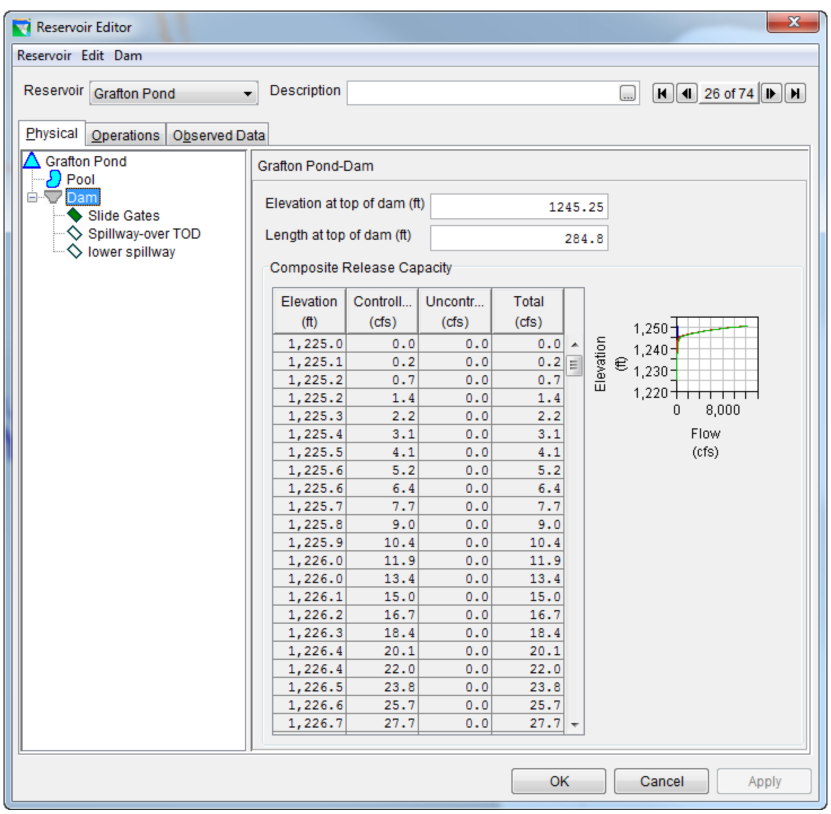


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Grafton Pond's "ExistingOps" operational zones, which consist of zones of Top of dam (1245.25 ft), Flood Control (1244.5 ft), Conservation (1239.5-1241.5 ft), and Inactive zone (1223.5 ft)[1].

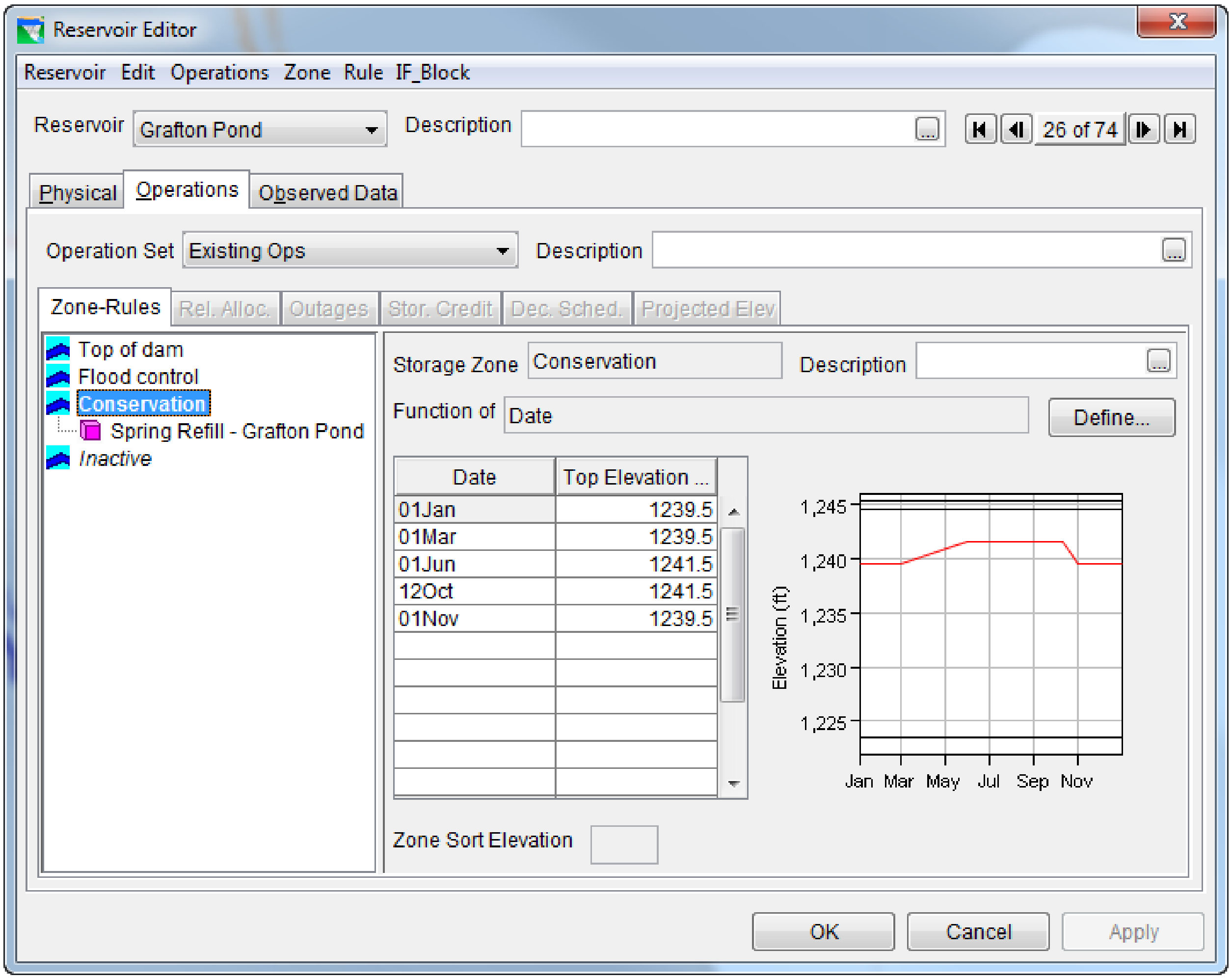


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

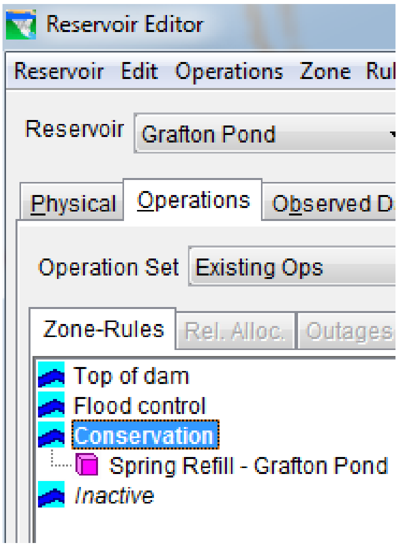


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Spring Refill-Grafton Pond

Figure 7 shows the content of "Spring Refill-Grafton Pond" rule. This rule defines the minimum release from reservoir as a function of Inflow.

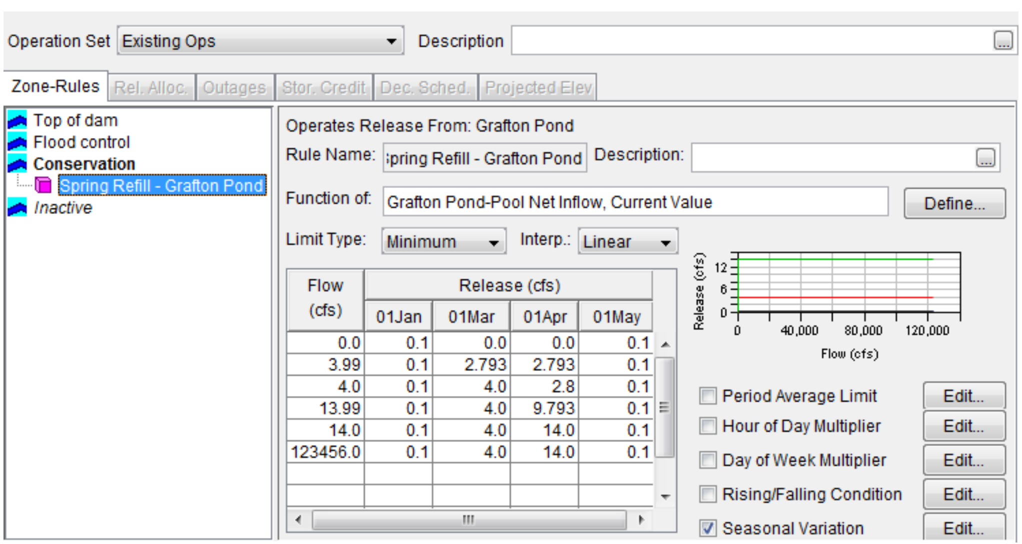


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Spring Refill-Grafton Pond

Harriman

I. Overview

Harriman dam is located upstream of the town of Readsboro on the Deerfield River. It is owned and operated by TransCanada Hydro Northeast Inc. for hydropower generation on a peaking, seasonal storage basis.

Figure 1 shows the location of Harriman Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from Harriman Dam.

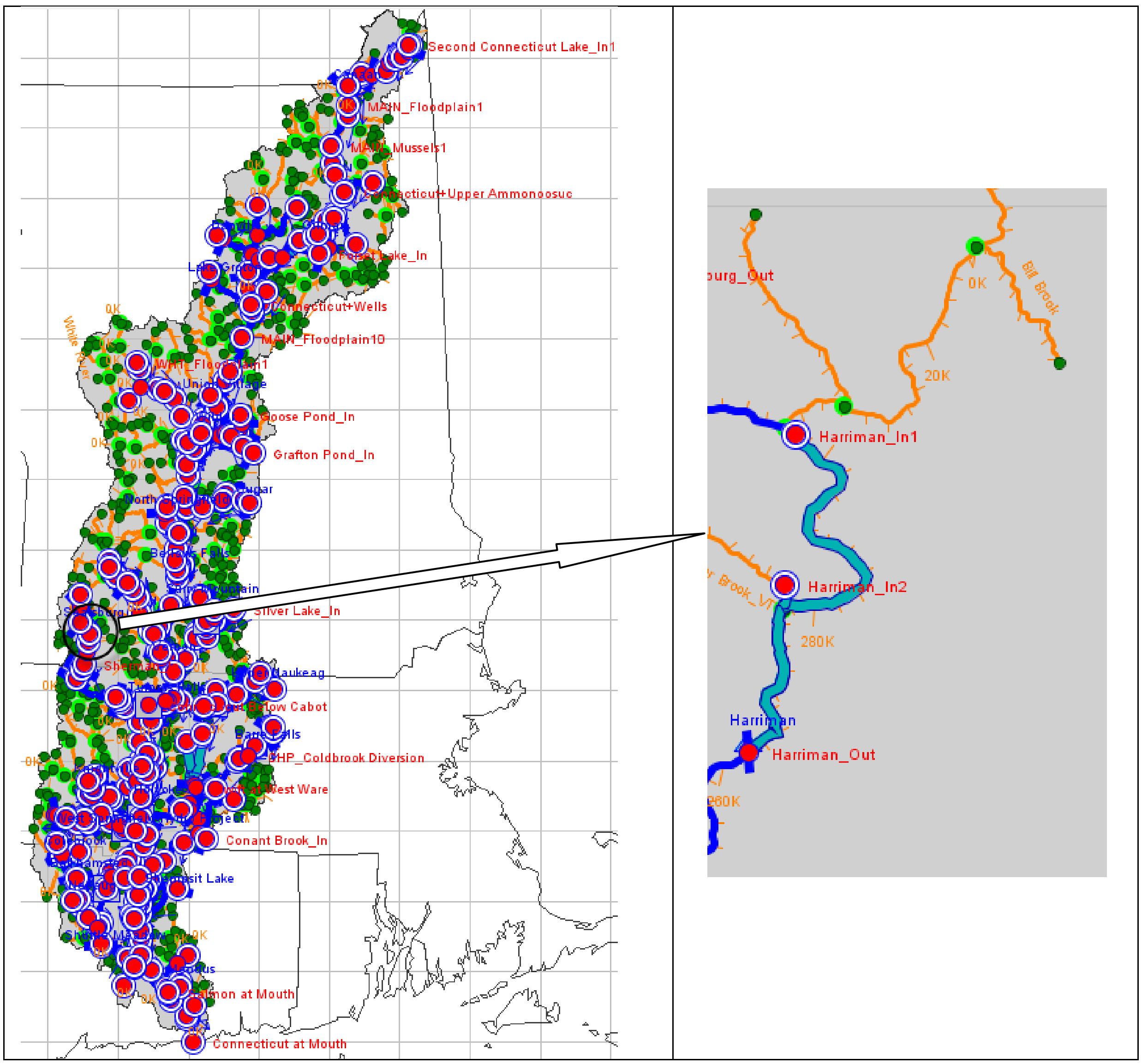


Figure 1: HEC-ResSim Map Display Showing Location of Harriman

Figure 2: Photo of Harriman Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[46]. The dam consists of four types of outlets: (1) uncontrolled spillway, (2) controlled spillway, (3) Howell Bunger Valve, and (4) power plant as shown in Figure 4.

[46] Data provided by TransCanada

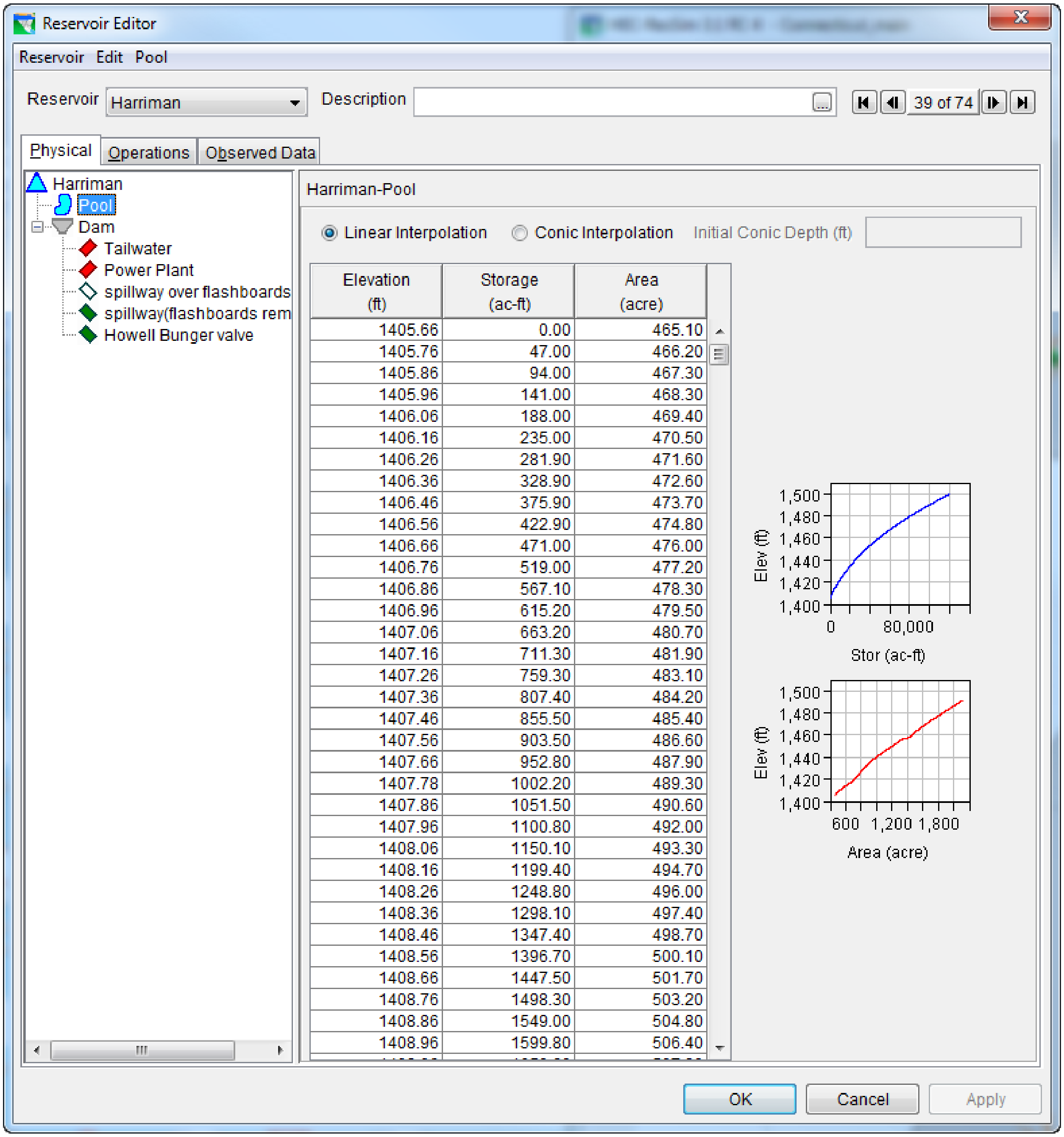
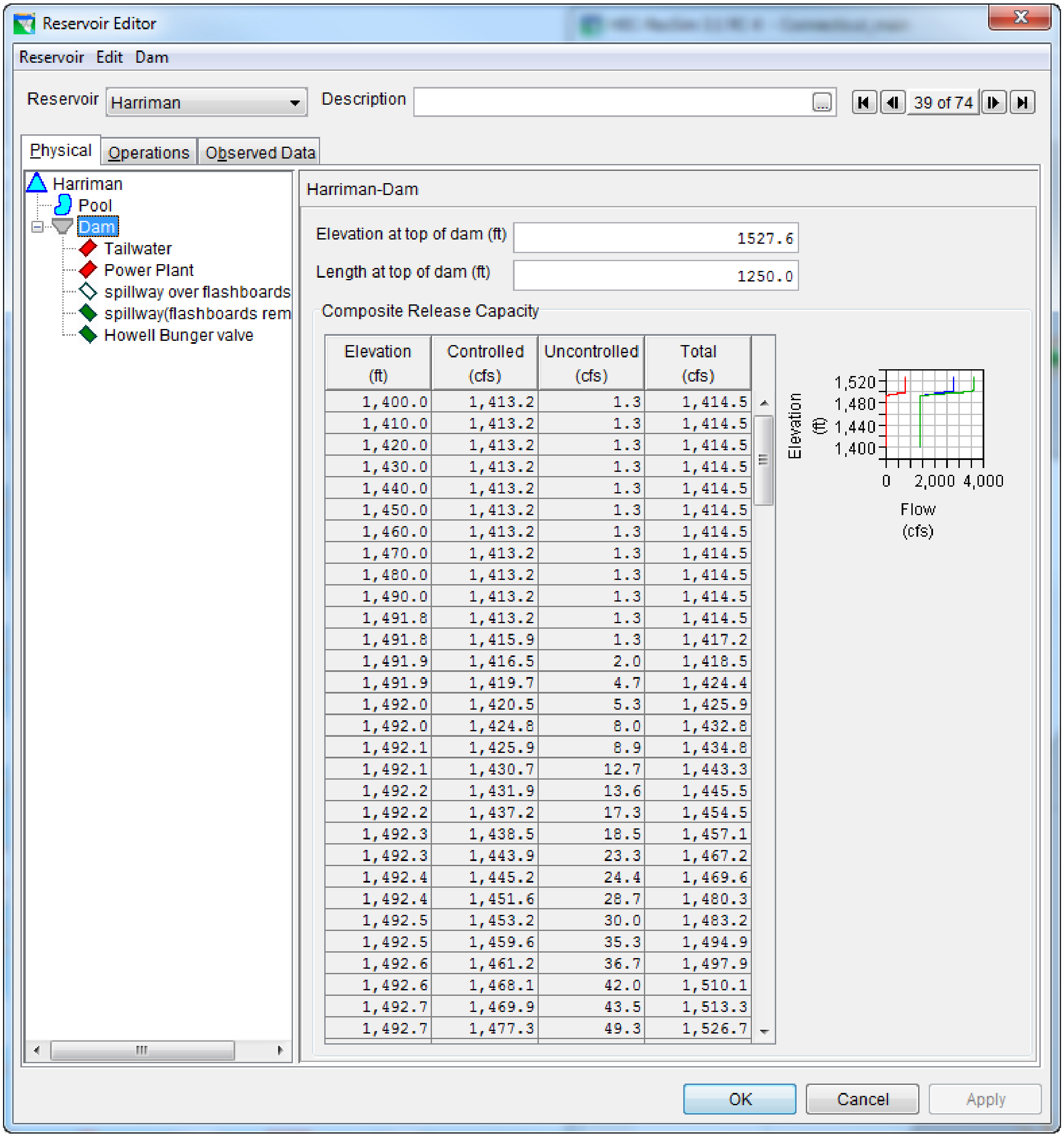


Figure 3: Reservoir Editor: Physical Tab -- Pool



Elevation (ft)	Controlled (cfs)	Uncontrolled (cfs)	Total (cfs)
1,400.0	1,413.2	1.3	1,414.5
1,410.0	1,413.2	1.3	1,414.5
1,420.0	1,413.2	1.3	1,414.5
1,430.0	1,413.2	1.3	1,414.5
1,440.0	1,413.2	1.3	1,414.5
1,450.0	1,413.2	1.3	1,414.5
1,460.0	1,413.2	1.3	1,414.5
1,470.0	1,413.2	1.3	1,414.5
1,480.0	1,413.2	1.3	1,414.5
1,490.0	1,413.2	1.3	1,414.5
1,491.8	1,413.2	1.3	1,414.5
1,491.8	1,415.9	1.3	1,417.2
1,491.9	1,416.5	2.0	1,418.5
1,491.9	1,419.7	4.7	1,424.4
1,492.0	1,420.5	5.3	1,425.9
1,492.0	1,424.8	8.0	1,432.8
1,492.1	1,425.9	8.9	1,434.8
1,492.1	1,430.7	12.7	1,443.3
1,492.2	1,431.9	13.6	1,445.5
1,492.2	1,437.2	17.3	1,454.5
1,492.3	1,438.5	18.5	1,457.1
1,492.3	1,443.9	23.3	1,467.2
1,492.4	1,445.2	24.4	1,469.6
1,492.4	1,451.6	28.7	1,480.3
1,492.5	1,453.2	30.0	1,483.2
1,492.5	1,459.6	35.3	1,494.9
1,492.6	1,461.2	36.7	1,497.9
1,492.6	1,468.1	42.0	1,510.1
1,492.7	1,469.9	43.5	1,513.3
1,492.7	1,477.3	49.3	1,526.7

Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Harriman's "ExistingOps" operational zones, which consist of zones of Top of dam (1527.6 ft), conservation (1497.6 ft), Min Pool (1440-1475 ft), and Inactive zone (1282.1 ft)[1].

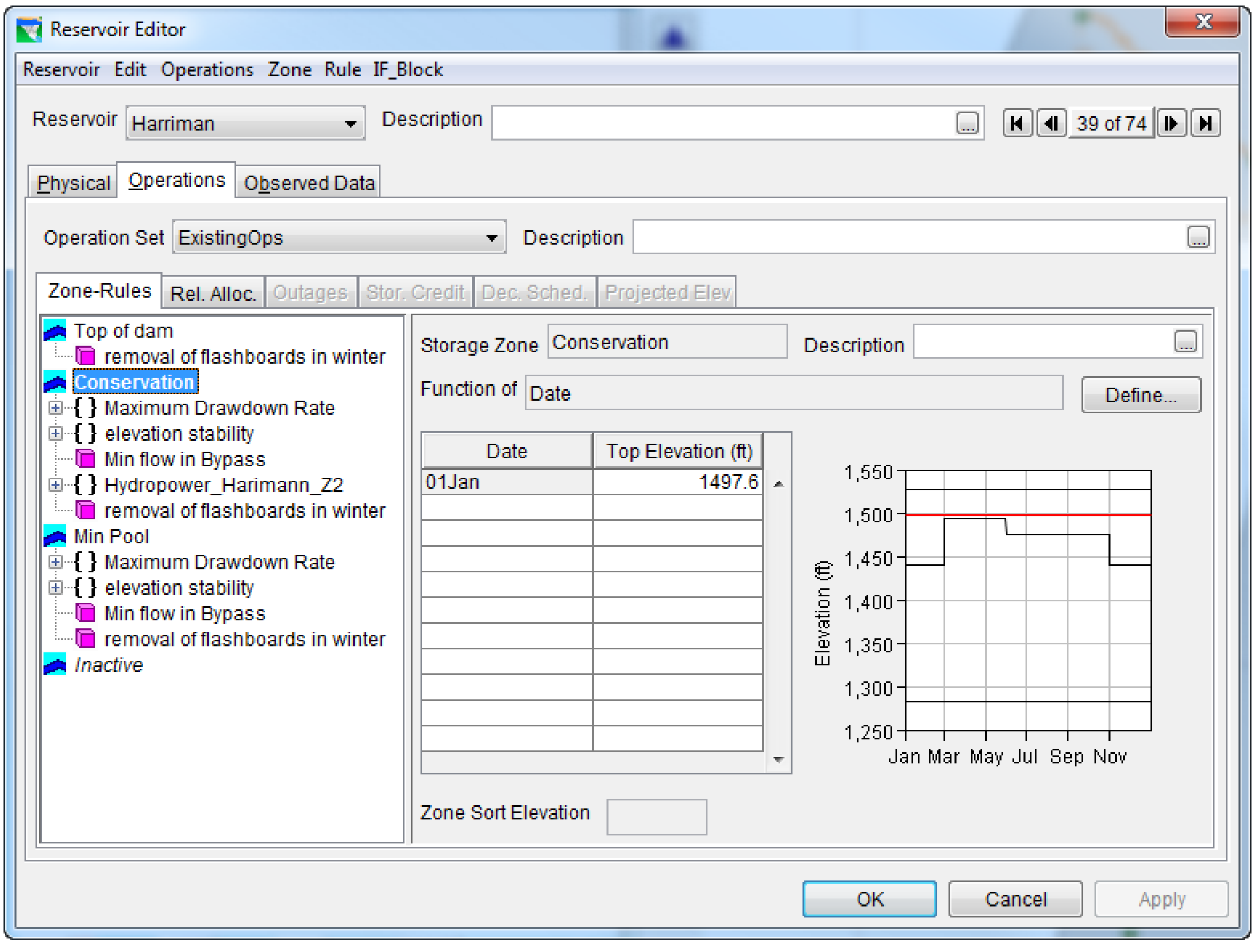


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Harriman Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The spillway gets the remainder of the release until it reaches capacity. After the capacity through the spillway is reached, the remainder of the release goes through the Howell Bunger Valve.

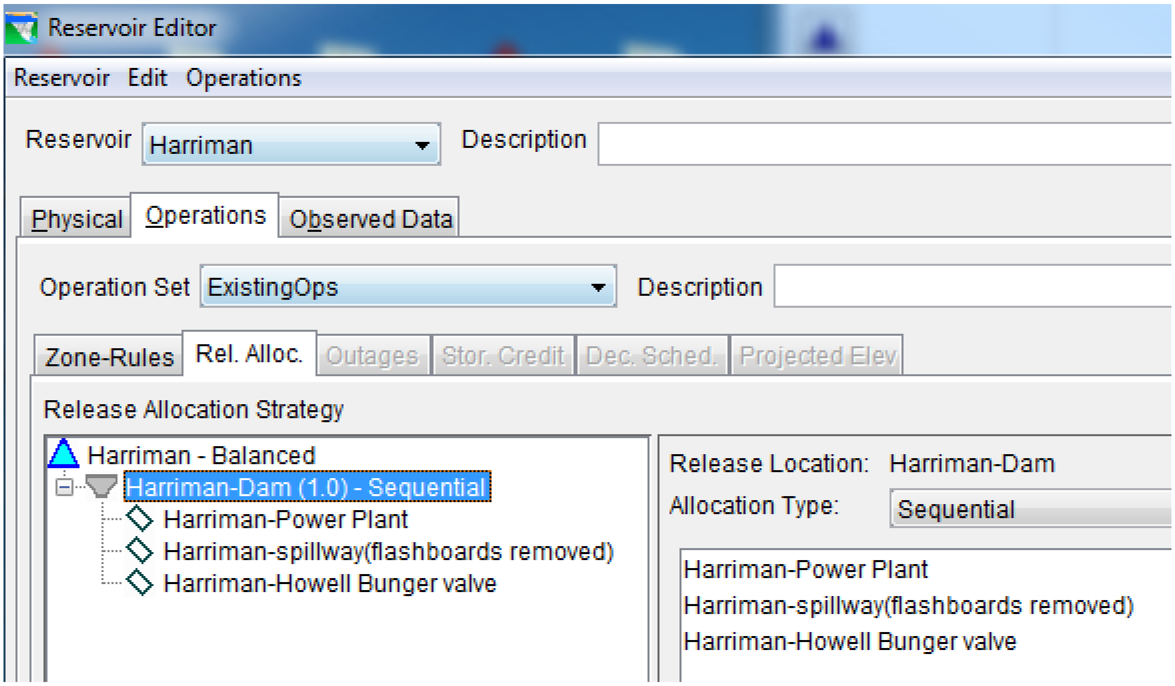


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[47].

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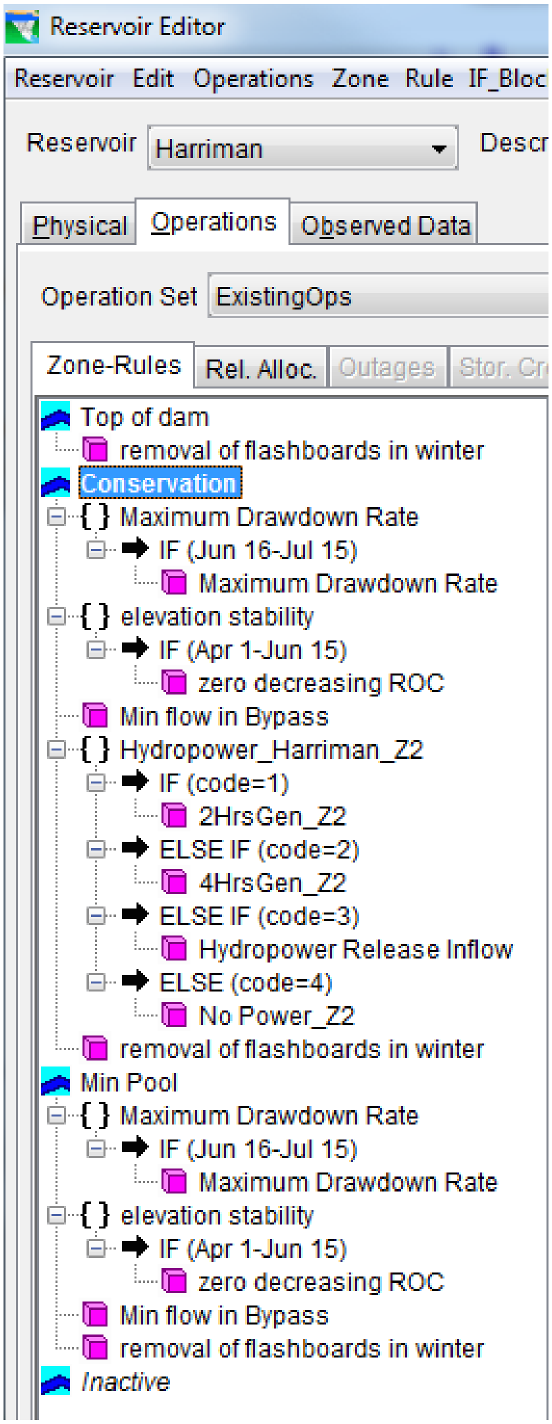


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[47] TransCanada. Deerfield River Operational Constraints. 2012.

C. Rule Descriptions

1. Removel of flashboards in winter

Figure 8 shows the content of "removal of flashboards in winter" rule. This rule represents the releases through spillways when the flashboards are removed in winters.

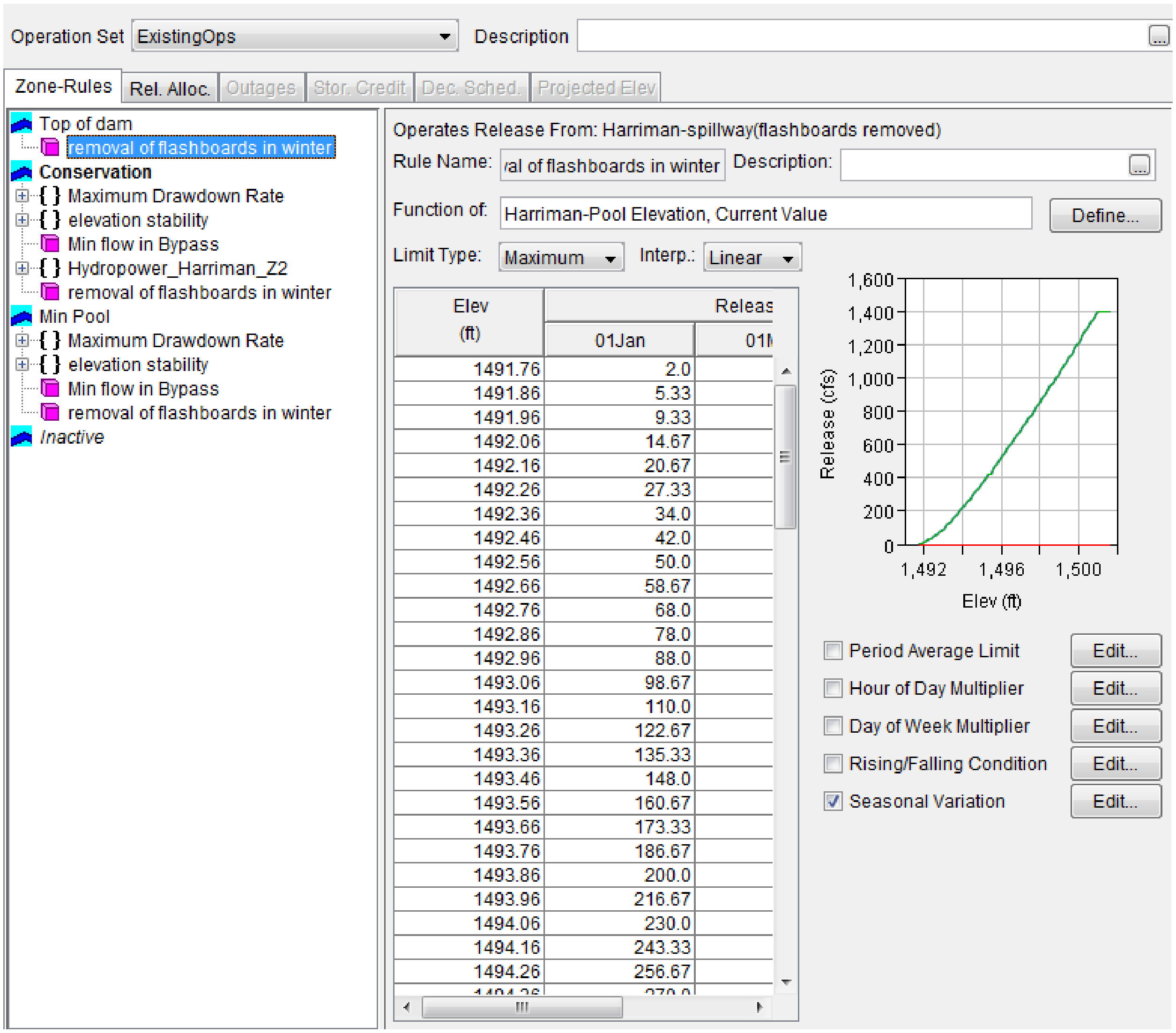
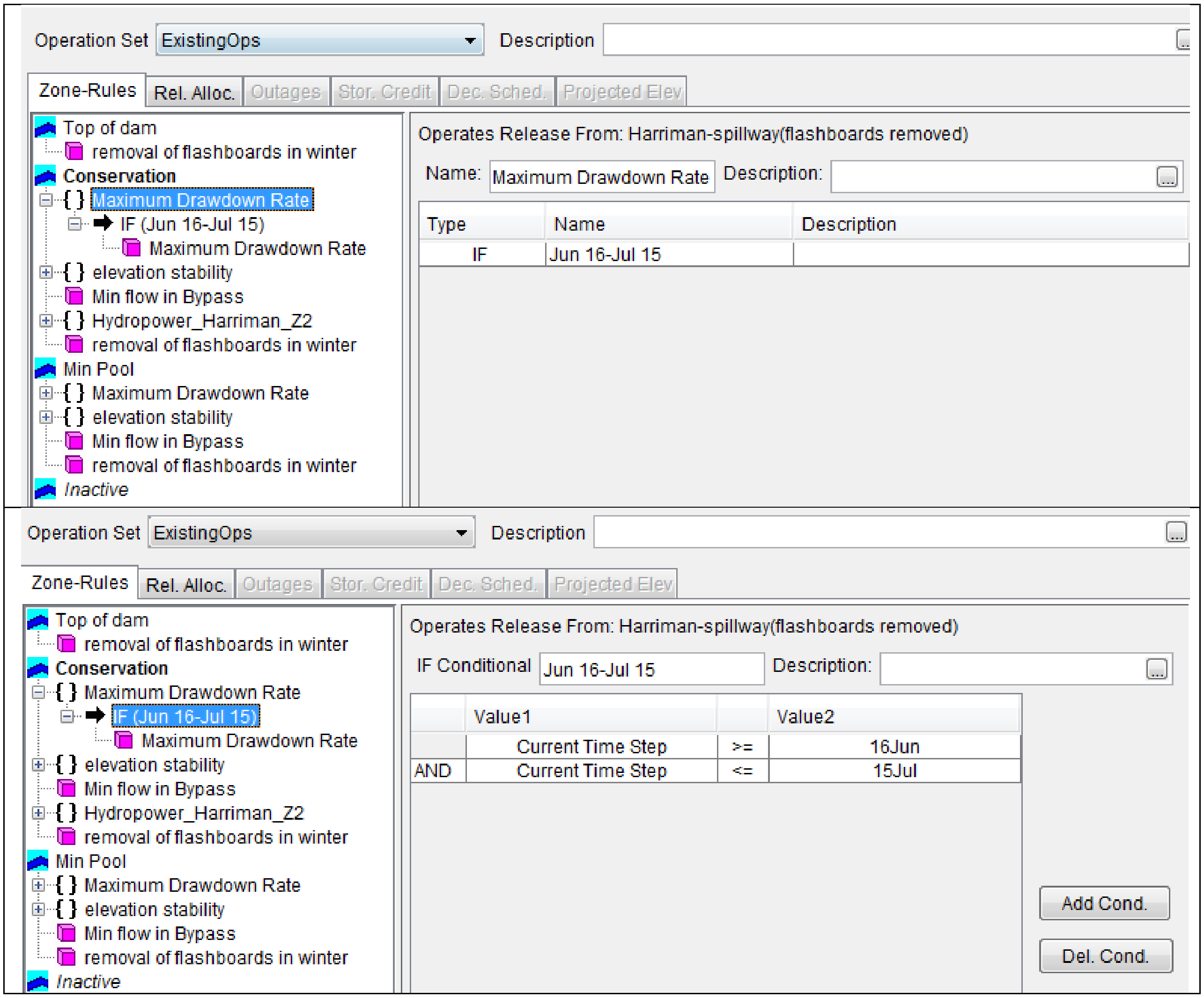


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – removal of flashboards in winter

2. *Maximum Drawdown Rate*

Figure 9 shows the content of "Maximum Drawdown Rate" rule. This rule limits the maximum change of elevation during 16Jun-15Jul.



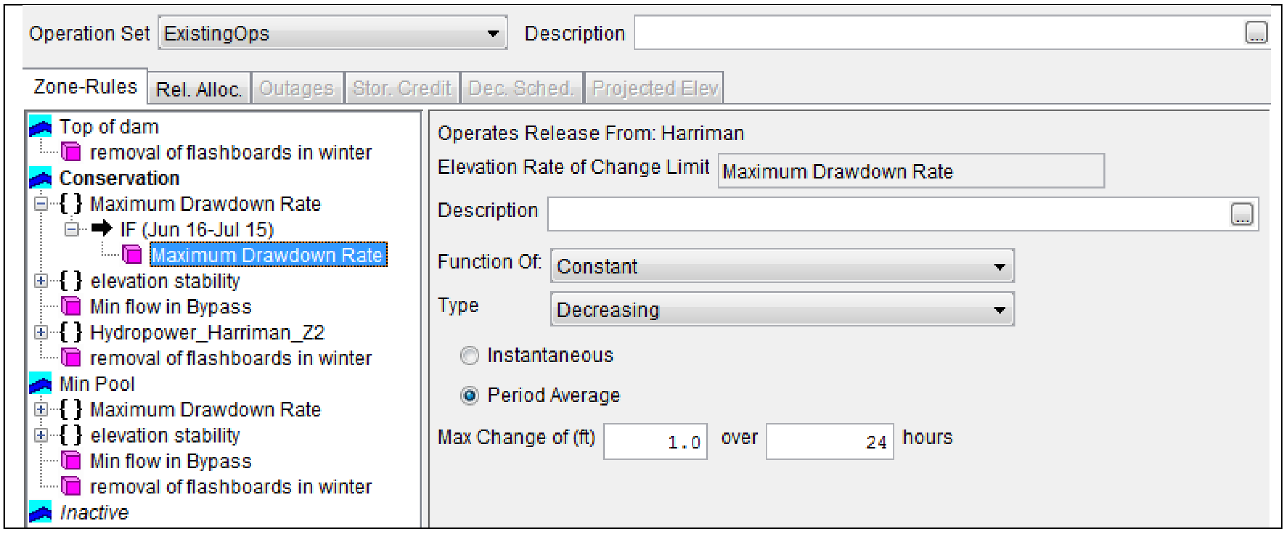
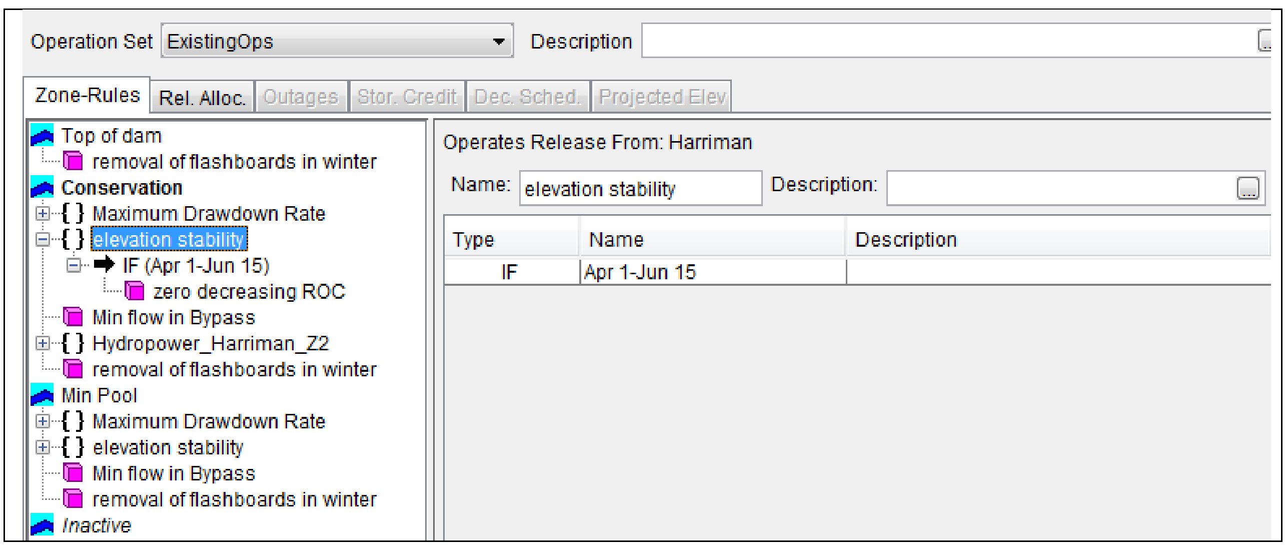


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maximum Drawdown Rate

3. Elevation Stability

As Figure 10 shows this rule represents zero rate of change during Apr 1-Jun 15 for Harriman.



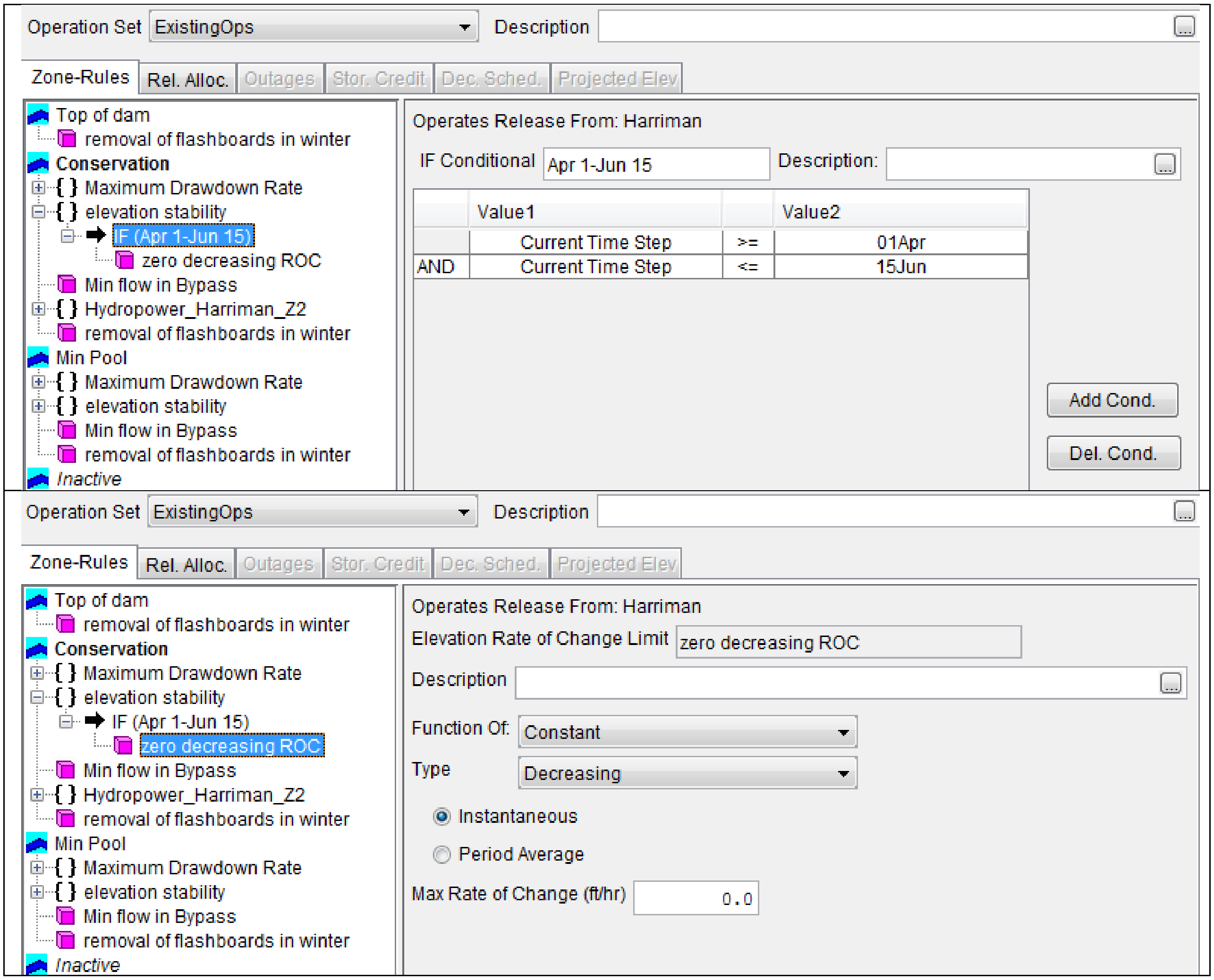
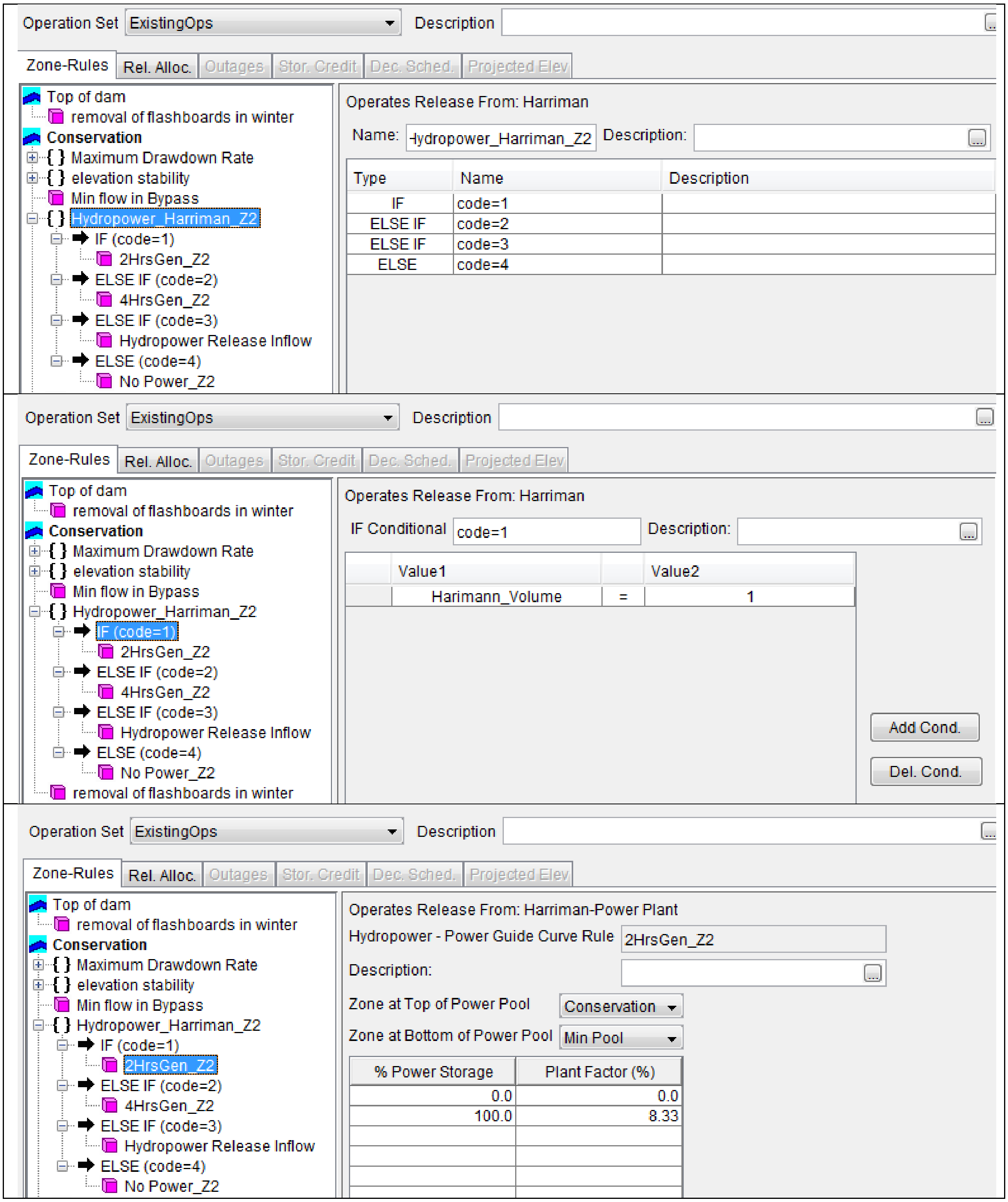
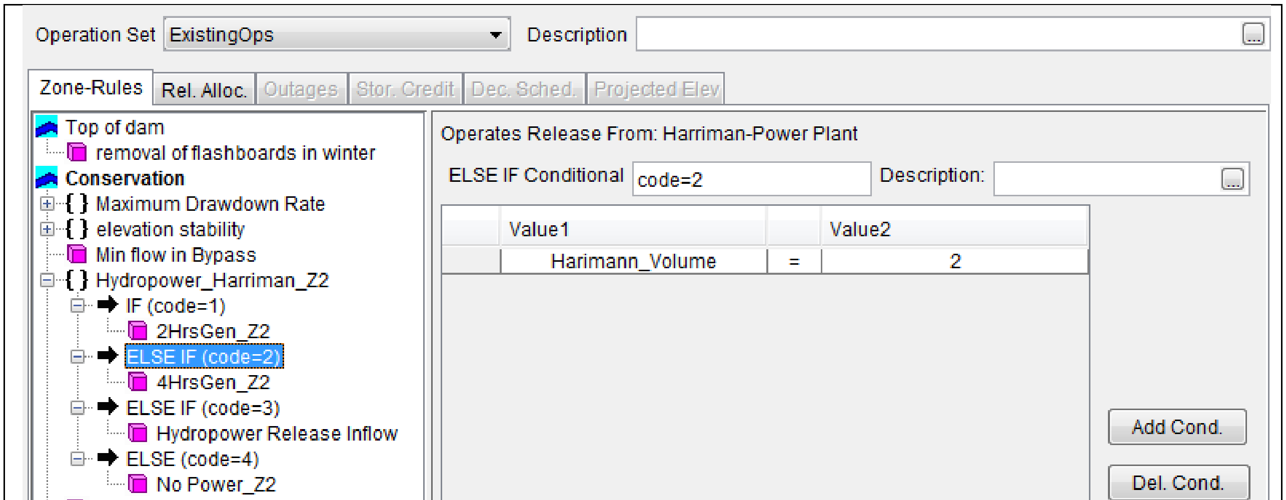


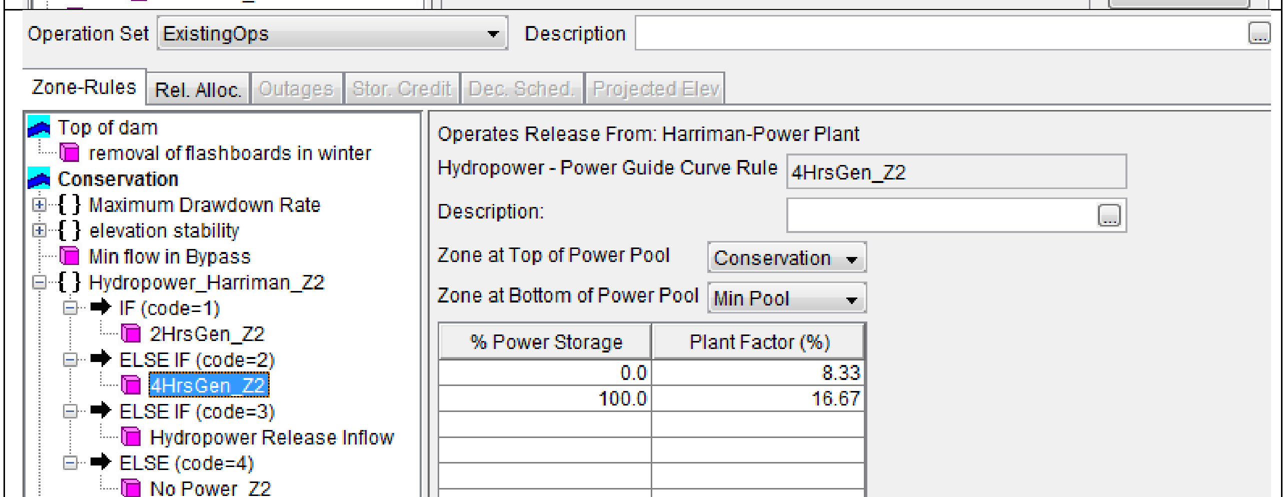
Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – elevation stability

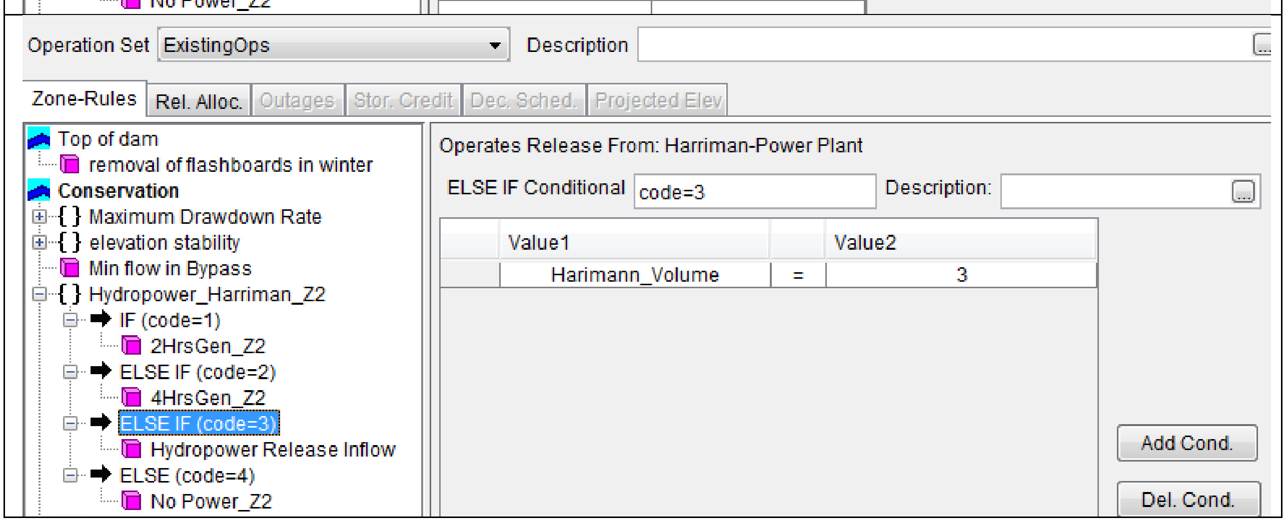
4. *Hydropower_Harriman_Z2*

This rule represents power strategy applied for Harriman reservoir. The content of the rule is shown in Figure 11 as per the peaking hydropower modeling strategy.




Operation Set ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
removal of flashboards in winter
Conservation
Maximum Drawdown Rate
elevation stability
Min flow in Bypass
Hydropower_Harriman_Z2
IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No Power_Z2
Operates Release From: Harriman-Power Plant
ELSE IF Conditional
code=2
Description:
Value1
Value2
Harimann_Volume
=
2
Add Cond.
Del. Cond.


Operation Set ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
removal of flashboards in winter
Conservation
Maximum Drawdown Rate
elevation stability
Min flow in Bypass
Hydropower_Harriman_Z2
IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No Power_Z2
Operates Release From: Harriman-Power Plant
Hydropower - Power Guide Curve Rule
4HrsGen_Z2
Description:
Zone at Top of Power Pool
Conservation
Zone at Bottom of Power Pool
Min Pool
% Power Storage
Plant Factor (%)
0.0
8.33
100.0
16.67


Operation Set ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
removal of flashboards in winter
Conservation
Maximum Drawdown Rate
elevation stability
Min flow in Bypass
Hydropower_Harriman_Z2
IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No Power_Z2
Operates Release From: Harriman-Power Plant
ELSE IF Conditional
code=3
Description:
Value1
Value2
Harimann_Volume
=
3
Add Cond.
Del. Cond.

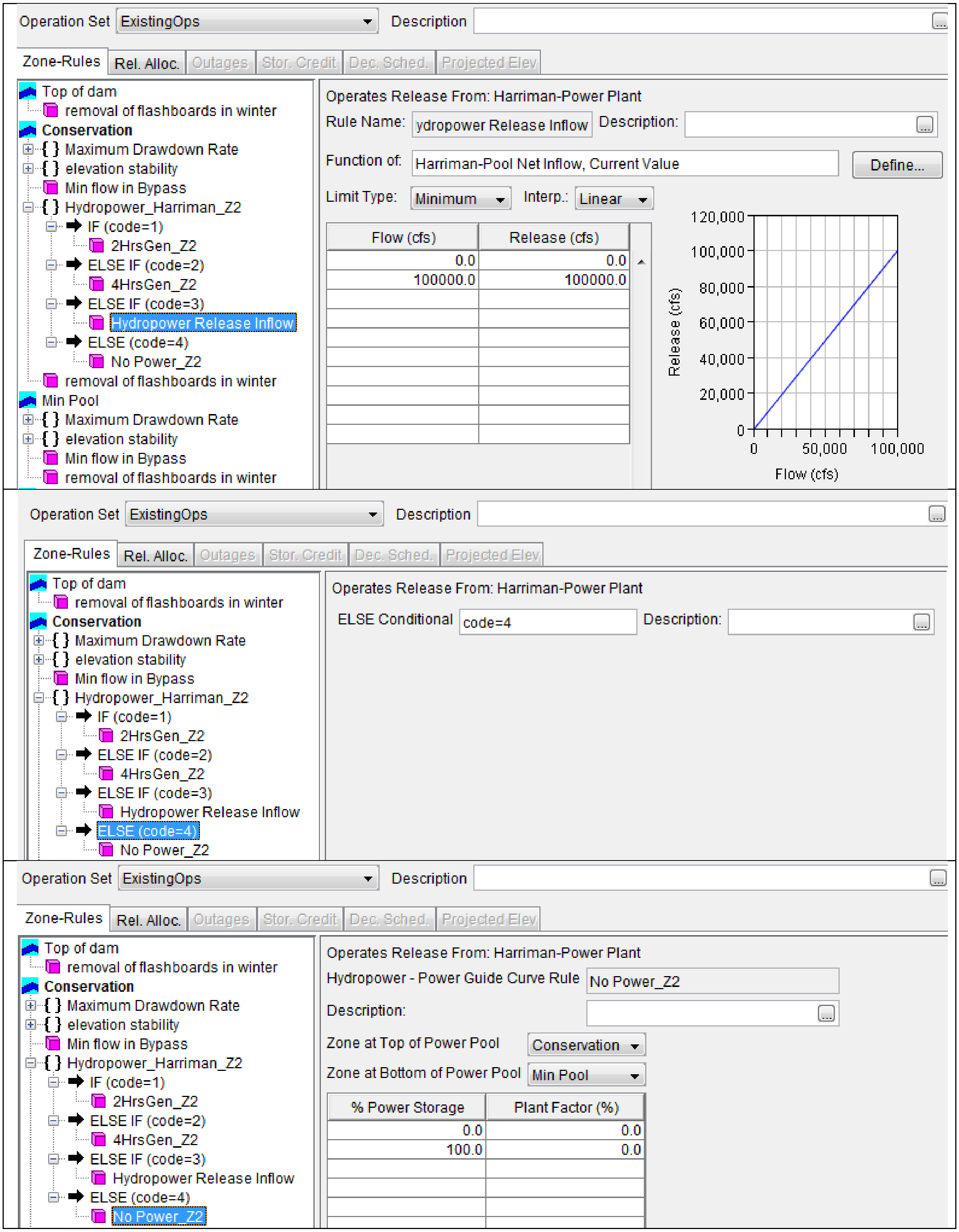


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Hydropower_Hariman_Z2

Figure 12 describes the definition of codes used in the Harriman_Volume state variable. The code is summing up the current Inflow and previous storage in each time step, compare it to the volume needed for generating 2 and 4 hours power and to the spillway storage minus inactive storage and then decide how much to release.

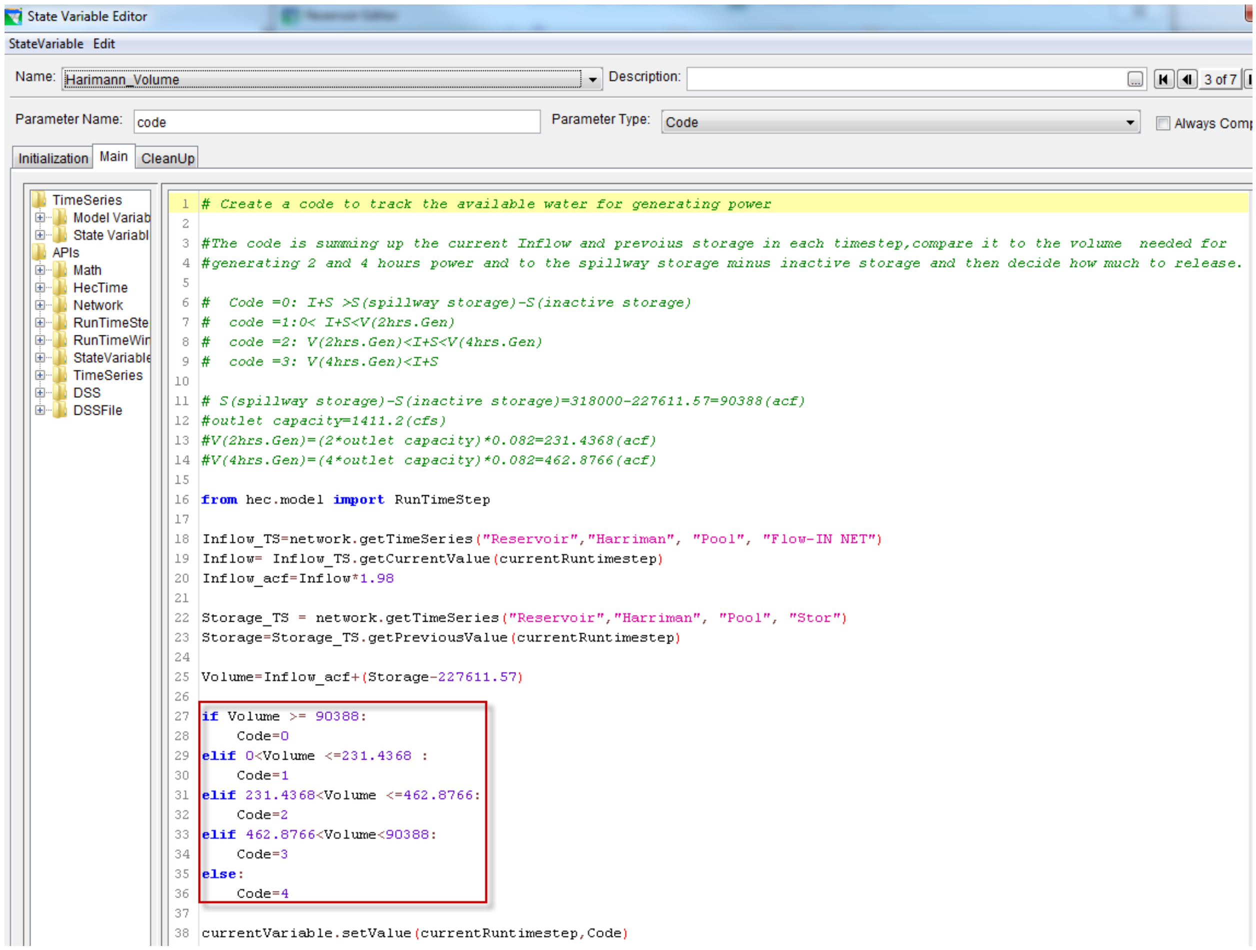


Figure 12: State Variable Editor: Harriman_Volume

5. *Min Flow in Bypass*

Figure 13 shows the content of Min Flow in Bypass. This rule represents the seasonal minimum flow releases required from Harriman.

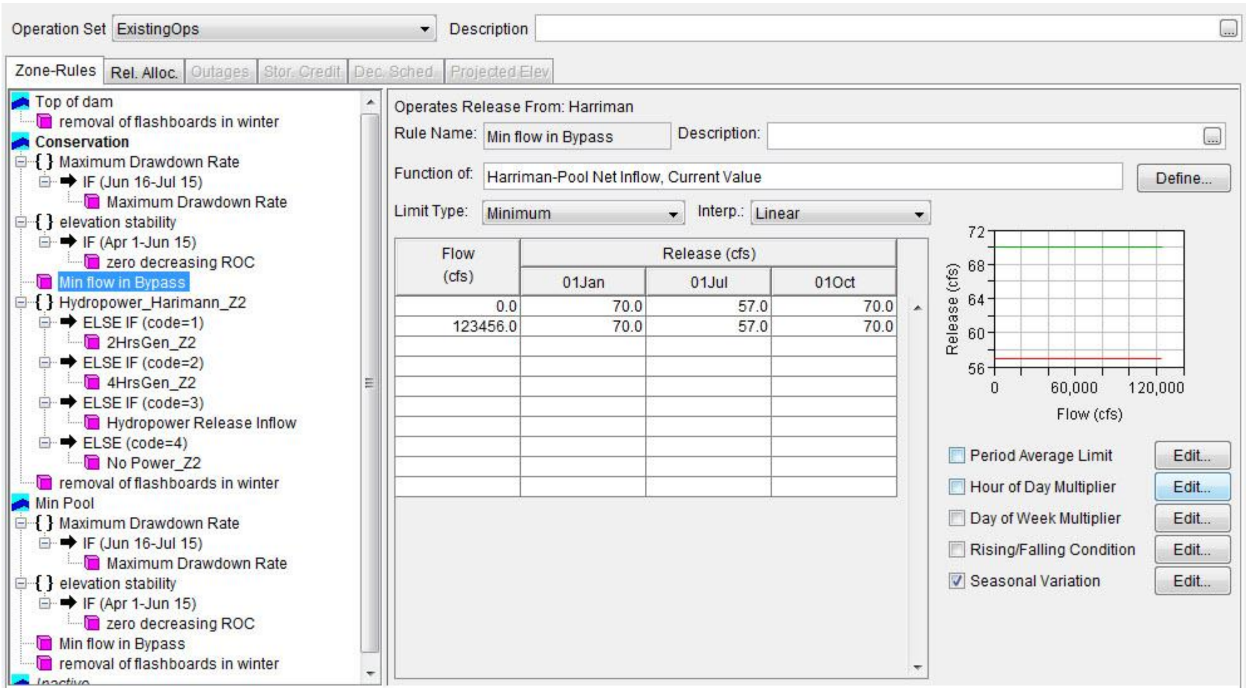


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min flow in Bypass

Holyoke

I. Overview

Holyoke dam is located in the City of Holyoke, MA and is the most downstream dam on the mainstem Connecticut River. It is owned and operated by the Holyoke Water Power Company and is used for hydropower generation.

Figure 1 shows the location of Holyoke Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from dam.

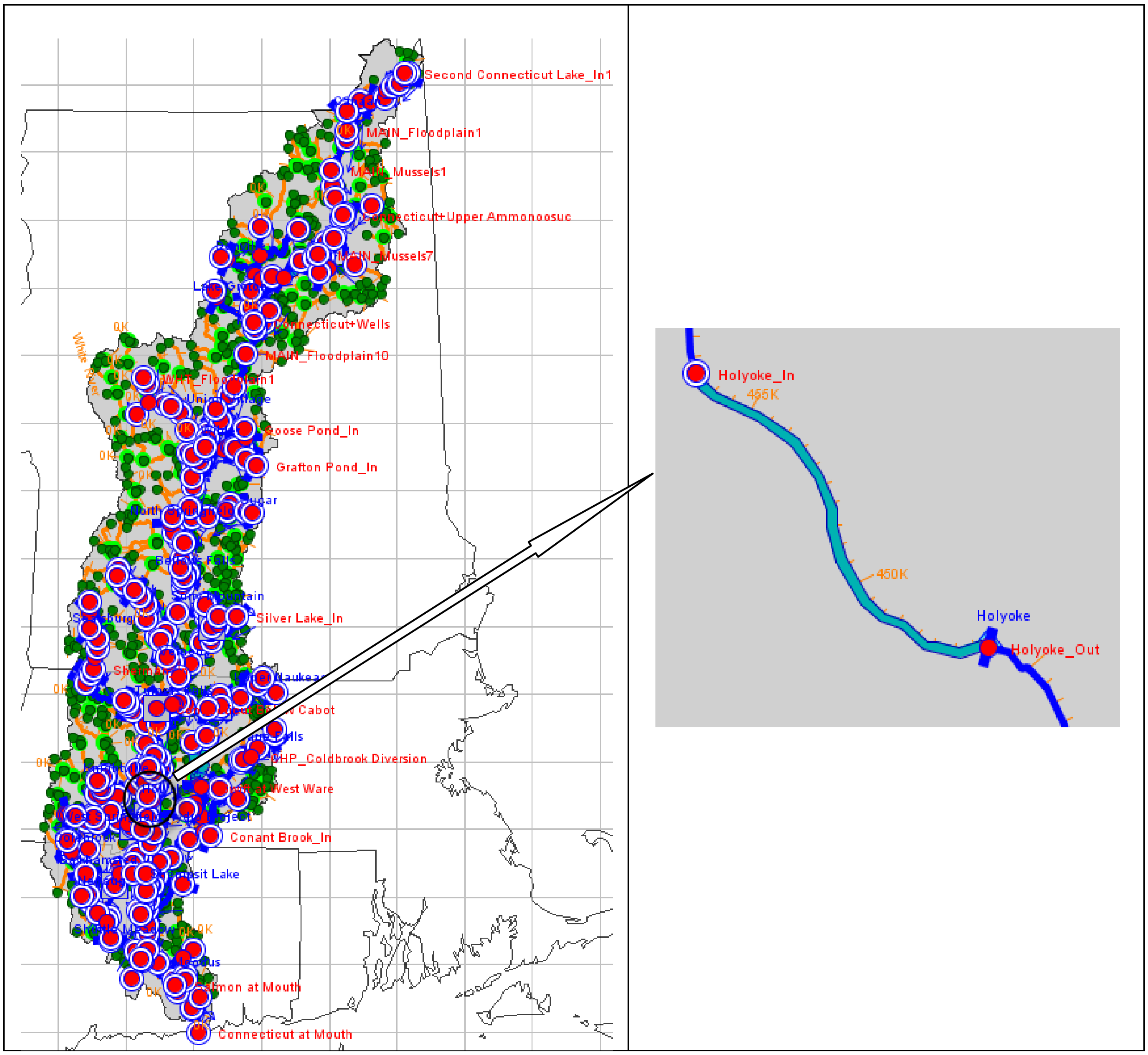


Figure 1: HEC-ResSim Map Display Showing Location of Holyoke dam

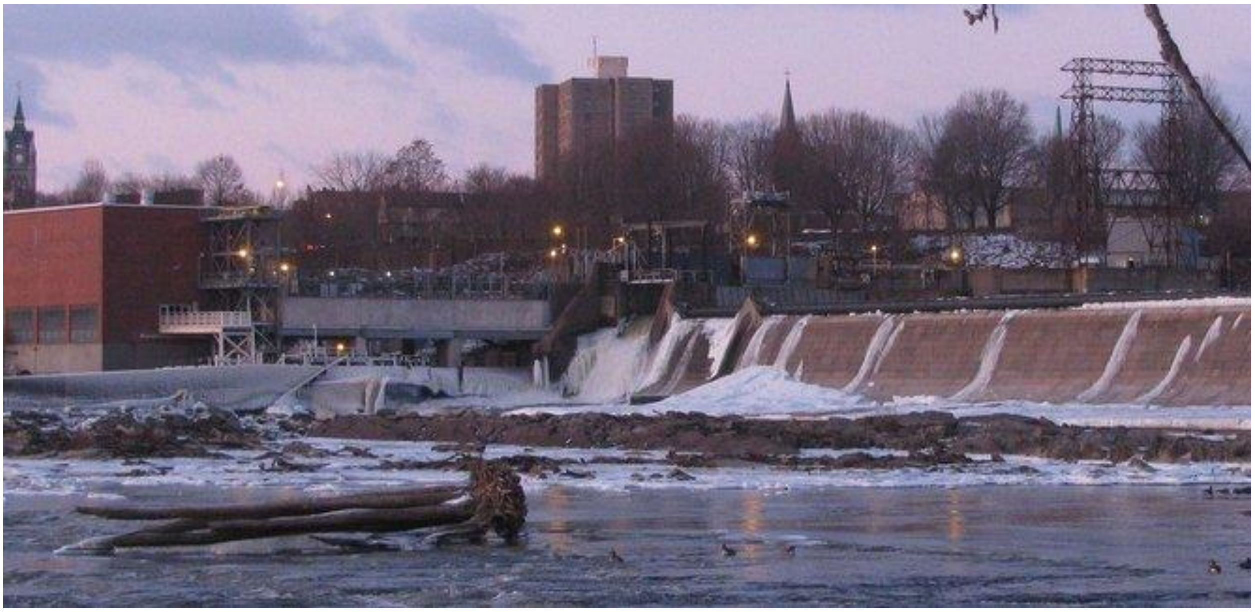


Figure 2: Photo from Holyoke dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[48]. The dam consists of five types of outlets: (1) controlled Bascule Gate, (2) controlled Bypass pipe, (3) controlled Canal System, (4) controlled Spillway with gates, and (5) power plant as shown in Figure 4.

[48]Data provided by UMASS

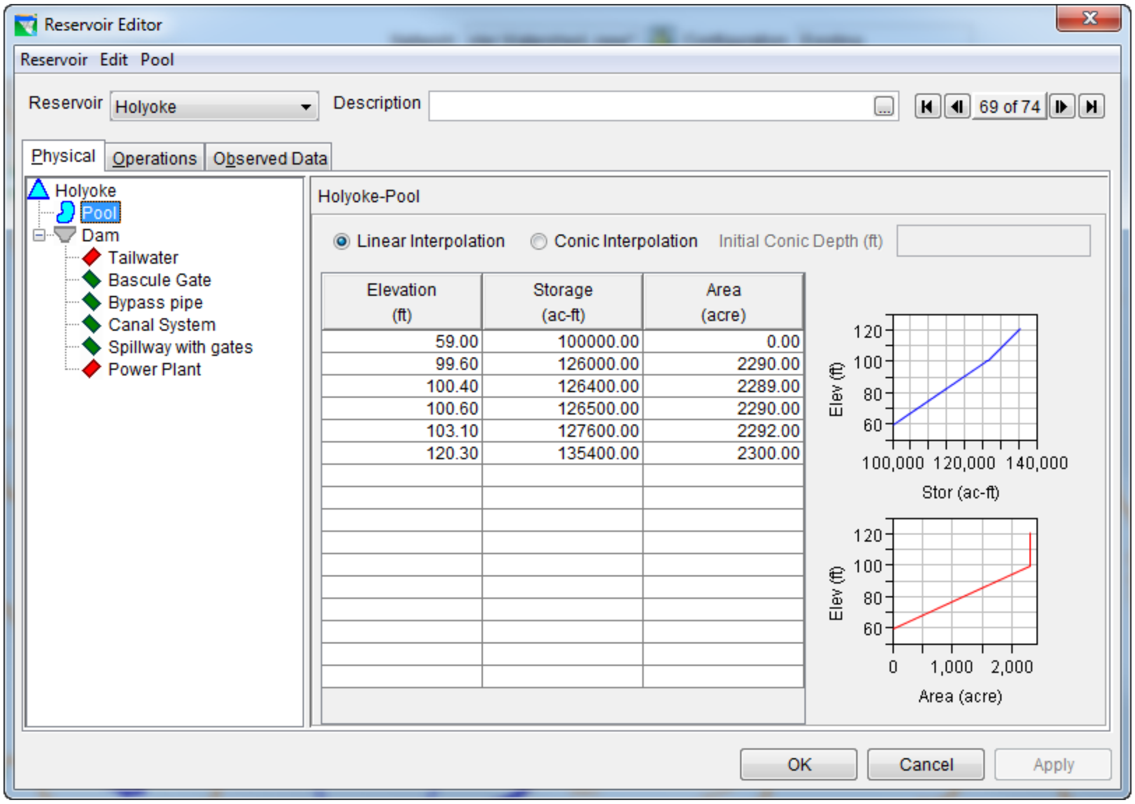


Figure 3: Reservoir Editor: Physical Tab -- Pool

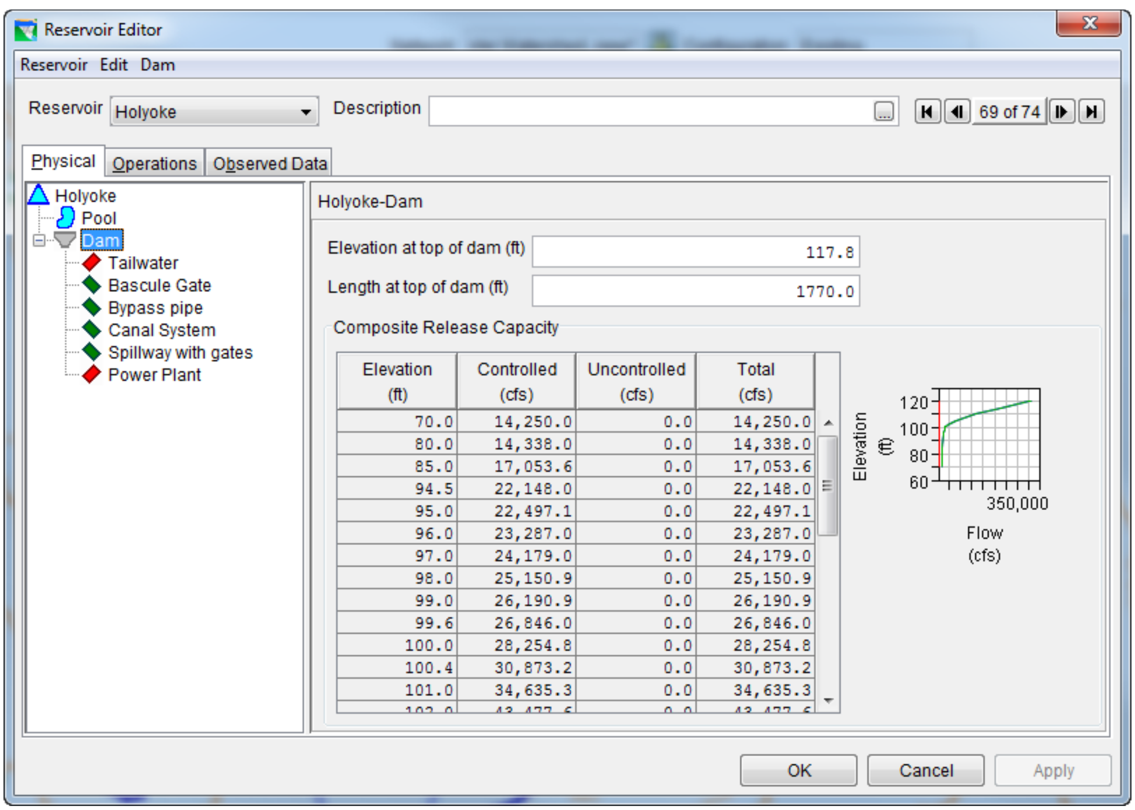


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 6 shows the definition of Holyoke's "ExistingOps" operational zones, which consist of zones of Flood Control (120.3 ft), Conservation (100.6 ft), and Inactive zone (68 ft)[1].

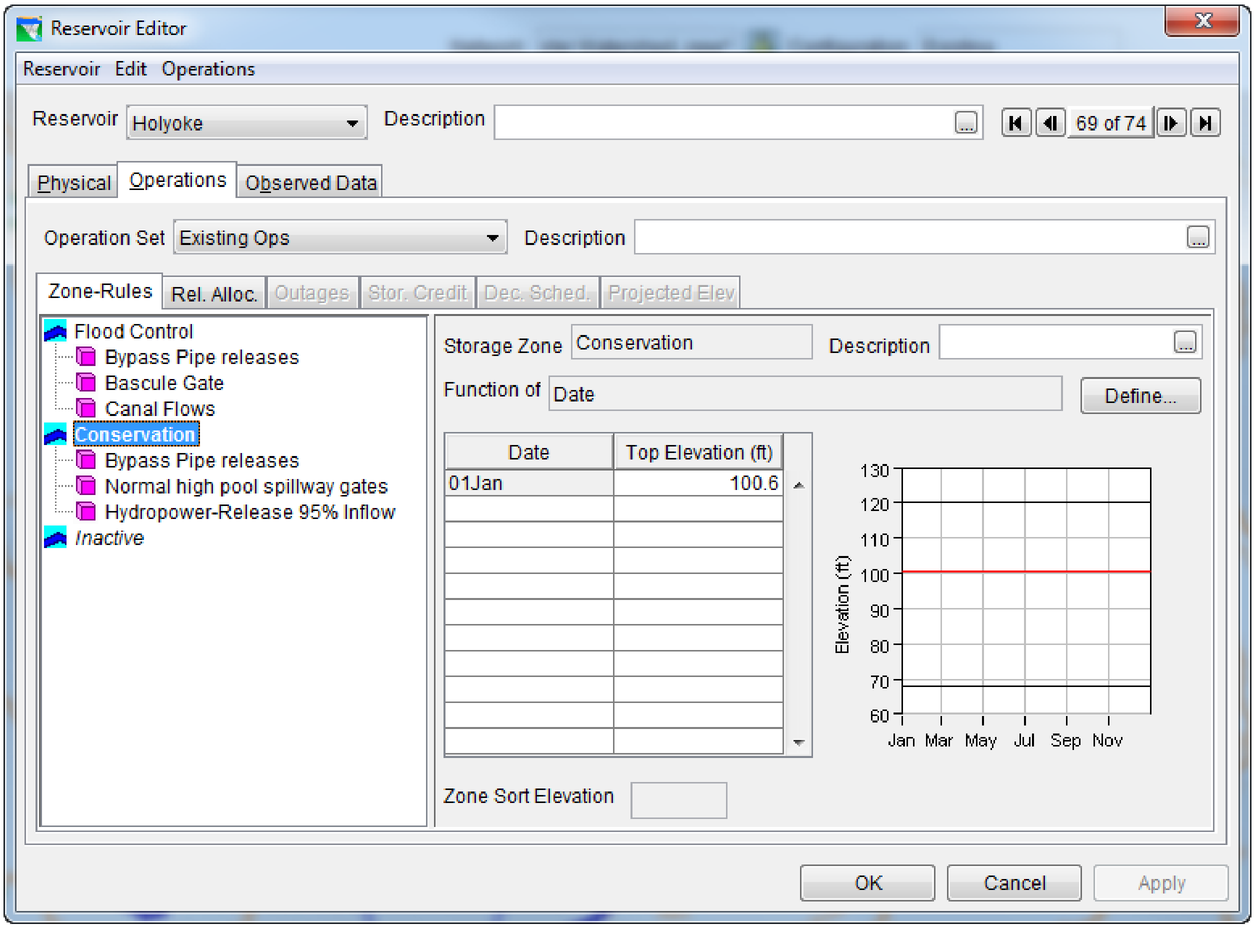


Figure 6: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[1].

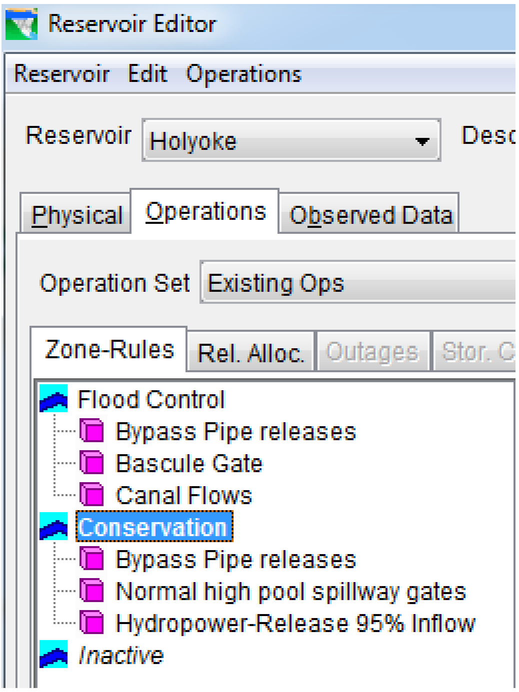


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

Figure 8 shows a sequential release allocation approach specified for available outlets along Bellows Falls Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The Bypass pipe gets the remainder of the release until it reaches capacity. Then the flow passes through the Canal System. After the capacity through the Canal System is reached, the remainder of the release goes through the Bascule gate and spillway with gates, respectively.

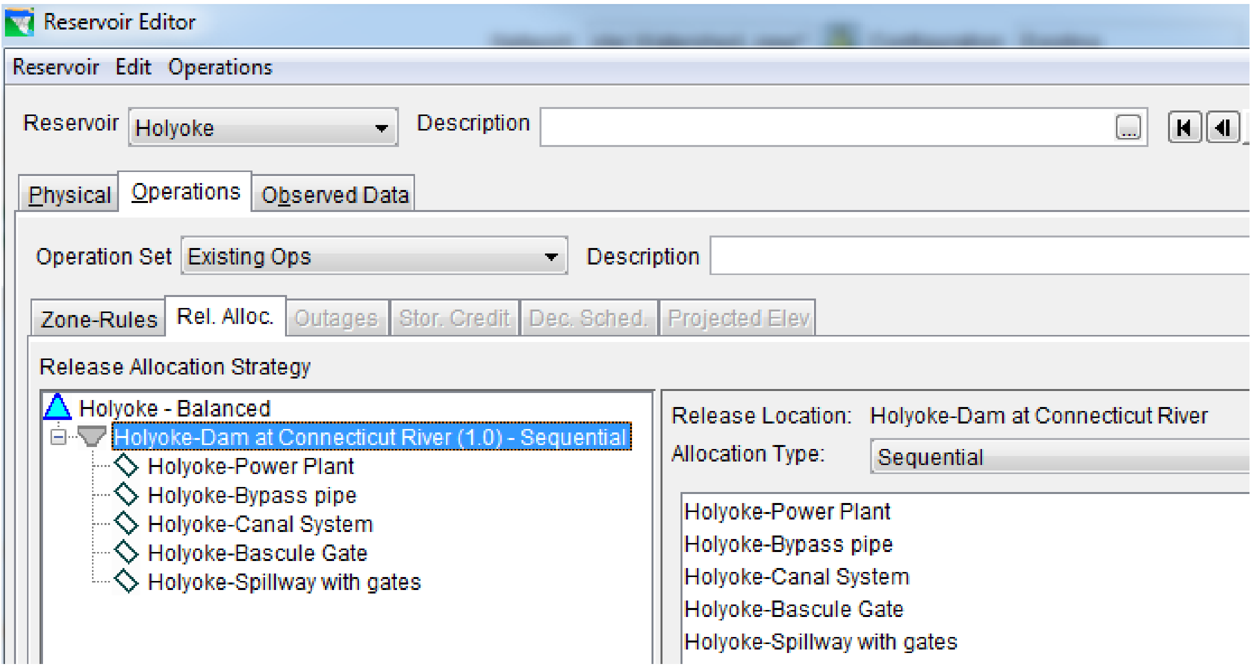


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

C. Rule Descriptions

1. Bypass Pipe release

Figure 9 shows the content of "Bypass Pipe release" rule. This rule represents a specified release from Bypass pipe controlled outlet.

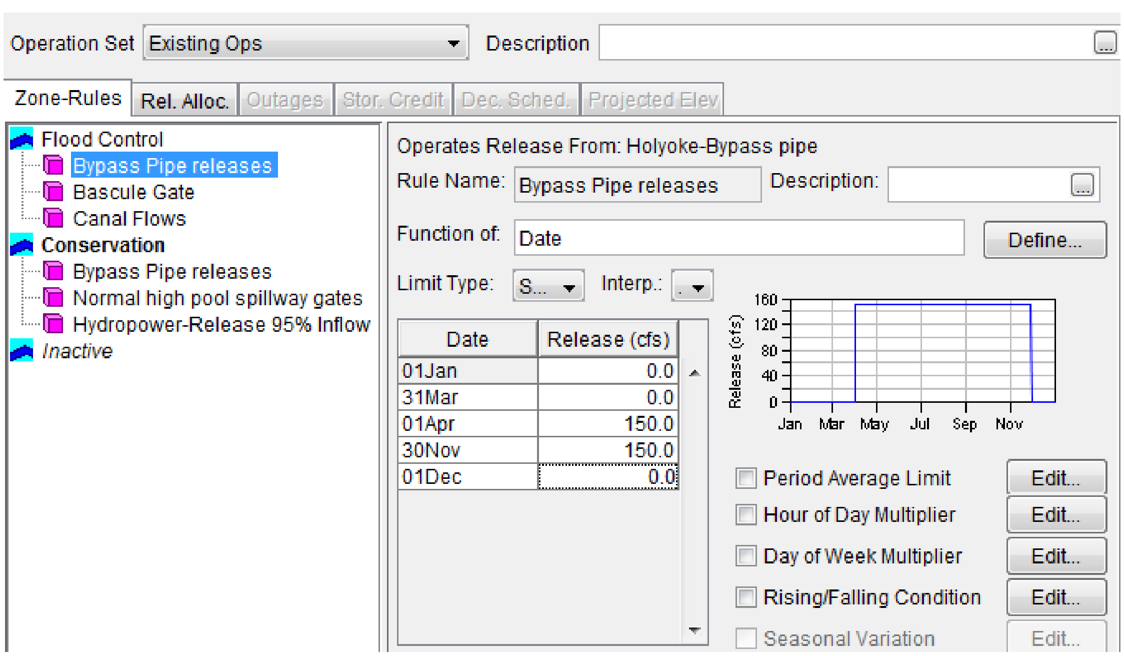
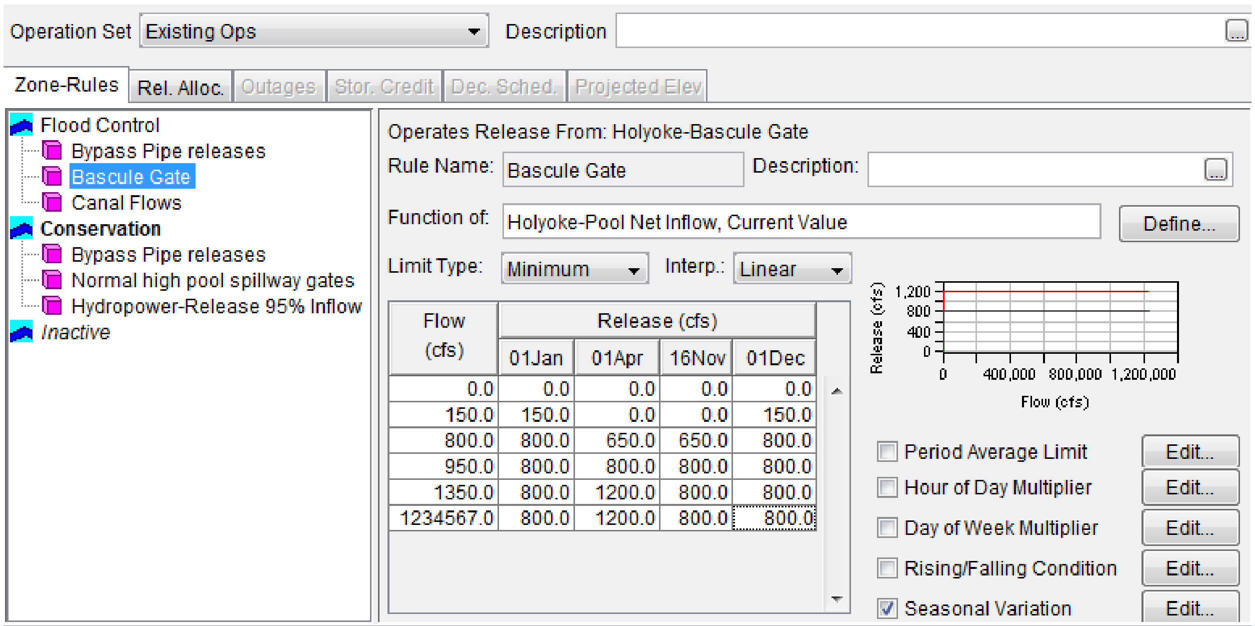


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Bypass Pipe release

2. *Bascule Gate*

Figure 10 shows the content of “Bascule Gate” rule. This rule represents the seasonal minimum release from Bascule gate controlled outlet.

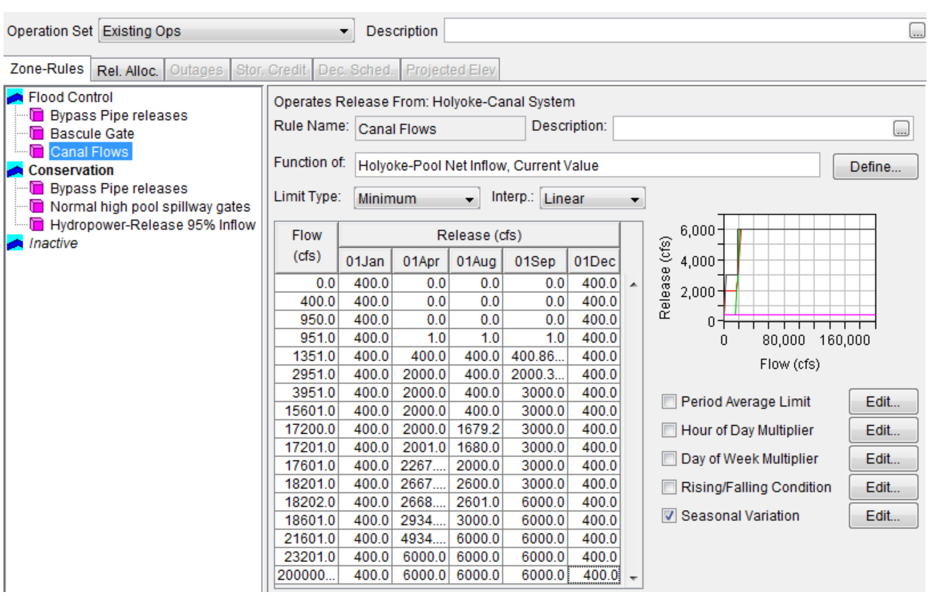


Flow (cfs)	Release (cfs) 01Jan	01Apr	16Nov	01Dec
0.0	0.0	0.0	0.0	0.0
150.0	150.0	0.0	0.0	150.0
800.0	800.0	650.0	650.0	800.0
950.0	800.0	800.0	800.0	800.0
1350.0	800.0	1200.0	800.0	800.0
1234567.0	800.0	1200.0	800.0	800.0

Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Bascule Gate

3. *Canal Flows*

Figure 11 shows the content of “Canal Flows” rule. This rule represents the seasonal minimum release from Canal System controlled outlet.



Flow (cfs)	Release (cfs) 01Jan	01Apr	01Aug	01Sep	01Dec
0.0	400.0	0.0	0.0	0.0	400.0
400.0	400.0	0.0	0.0	0.0	400.0
950.0	400.0	0.0	0.0	0.0	400.0
951.0	400.0	1.0	1.0	1.0	400.0
1351.0	400.0	400.0	400.0	400.86...	400.0
2951.0	400.0	2000.0	400.0	2000.3...	400.0
3951.0	400.0	2000.0	400.0	3000.0	400.0
15601.0	400.0	2000.0	400.0	3000.0	400.0
17200.0	400.0	2000.0	1679.2	3000.0	400.0
17201.0	400.0	2001.0	1680.0	3000.0	400.0
17601.0	400.0	2267....	2000.0	3000.0	400.0
18201.0	400.0	2667....	2600.0	3000.0	400.0
18202.0	400.0	2668....	2601.0	6000.0	400.0
18601.0	400.0	2934....	3000.0	6000.0	400.0
21601.0	400.0	4934....	6000.0	6000.0	400.0
23201.0	400.0	6000.0	6000.0	6000.0	400.0
200000...	400.0	6000.0	6000.0	6000.0	400.0

Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Canal Flows

4. *Normal high pool spillway gates*

Figure 12 shows the content of “Normal high pool spillway gates” rule. This rule makes no releases from Spillway with gates controlled outlet.

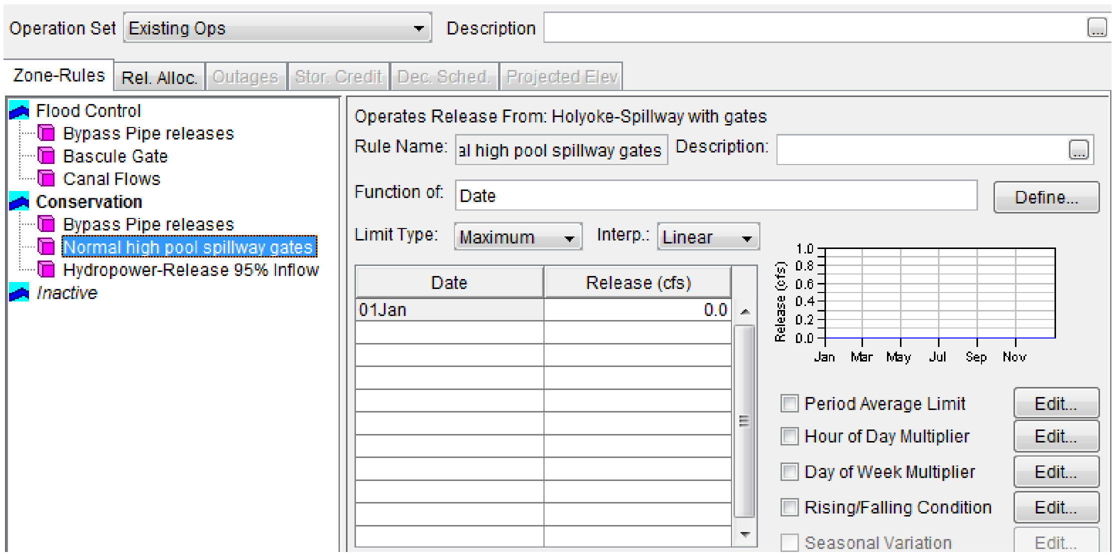


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Normal high pool spillway gates

5. *Hydropower-Release 95% Inflow*

Figure 13 shows the content of “Hydropower –Release 95% Inflow” rule. This rule releases the 95% of inflow through power plant as per the run-of-river modeling strategy.

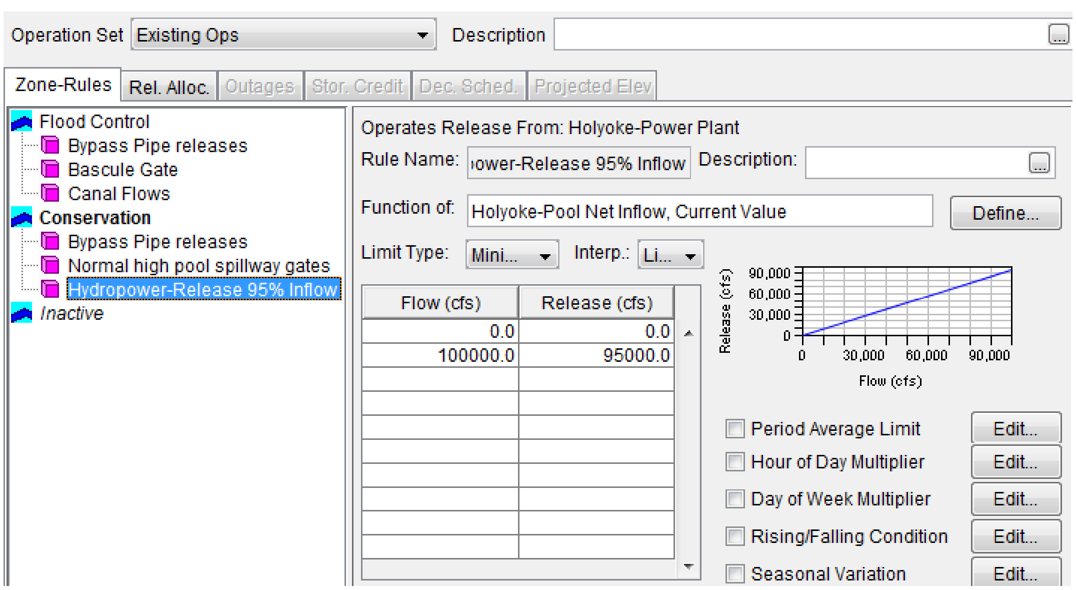


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Hydropower-Release 95% Inflow

Knightville

I. Overview

Knightville Dam is located on the North Branch of the Westfield River near the town of Knightville in Hampshire County, Massachusetts, USA. The U.S. Army Corps of Engineers constructed the dam in 1941 and is still owned and operated by the Corps. It is primarily used for flood control but also for recreation.

Figure 1 shows the location of Knightville Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the dam.

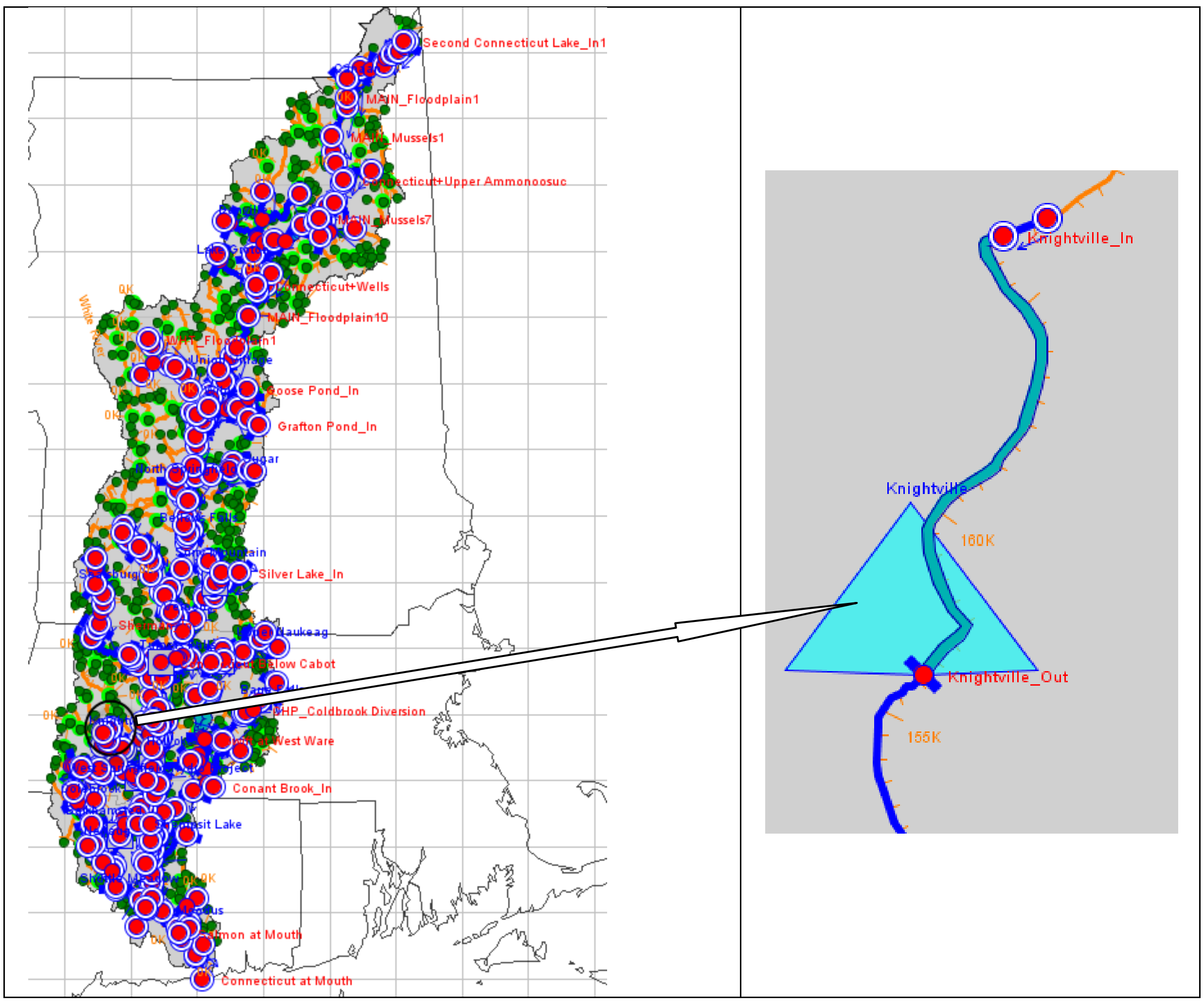


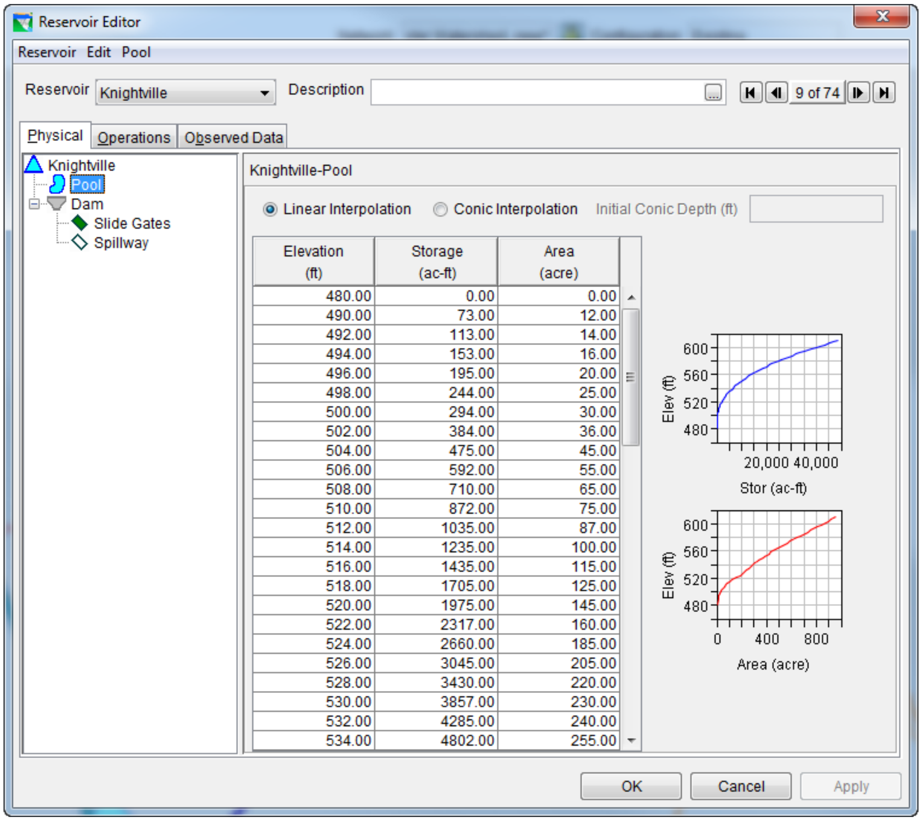
Figure 1: HEC-ResSim Map Display Showing Location of Knightville dam

Figure 2: Photo of Knightville Dam

II. Physical Characteristics

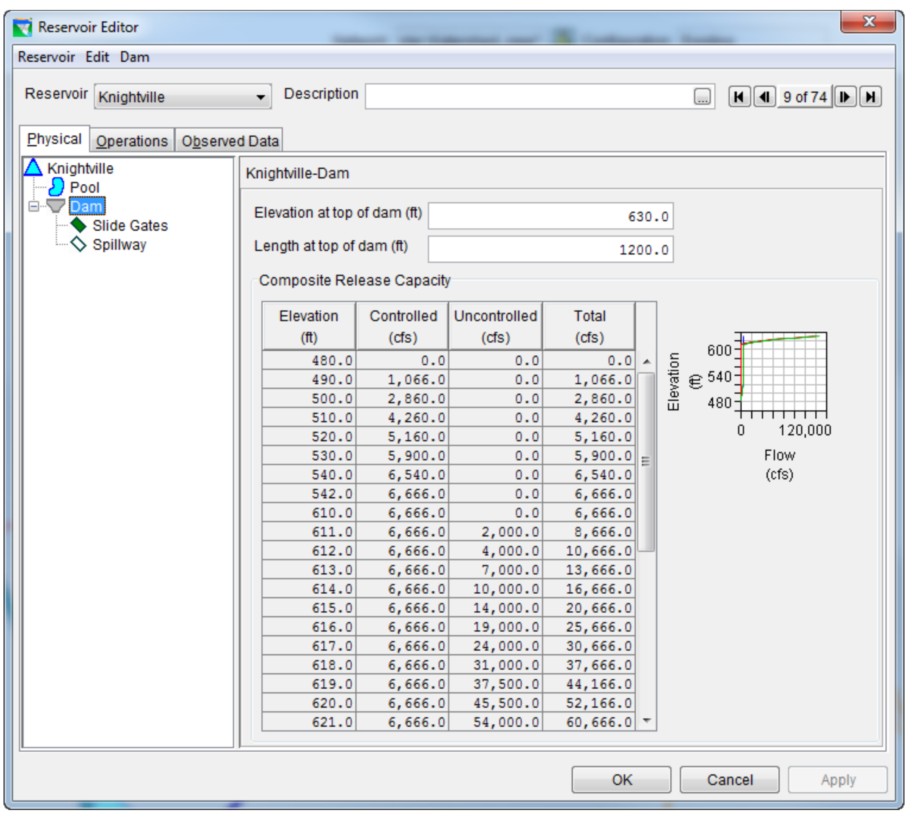
The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled slide gates, and (2) uncontrolled spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[49].

[49] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index



Elevation (ft)	Storage (ac-ft)	Area (acre)
480.00	0.00	0.00
490.00	73.00	12.00
492.00	113.00	14.00
494.00	153.00	16.00
496.00	195.00	20.00
498.00	244.00	25.00
500.00	294.00	30.00
502.00	384.00	36.00
504.00	475.00	45.00
506.00	592.00	55.00
508.00	710.00	65.00
510.00	872.00	75.00
512.00	1035.00	87.00
514.00	1235.00	100.00
516.00	1435.00	115.00
518.00	1705.00	125.00
520.00	1975.00	145.00
522.00	2317.00	160.00
524.00	2660.00	185.00
526.00	3045.00	205.00
528.00	3430.00	220.00
530.00	3857.00	230.00
532.00	4285.00	240.00
534.00	4802.00	255.00

Figure 3: Reservoir Editor: Physical Tab -- Pool



Elevation (ft)	Controlled (cfs)	Uncontrolled (cfs)	Total (cfs)
480.0	0.0	0.0	0.0
490.0	1,066.0	0.0	1,066.0
500.0	2,860.0	0.0	2,860.0
510.0	4,260.0	0.0	4,260.0
520.0	5,160.0	0.0	5,160.0
530.0	5,900.0	0.0	5,900.0
540.0	6,540.0	0.0	6,540.0
542.0	6,666.0	0.0	6,666.0
610.0	6,666.0	0.0	6,666.0
611.0	6,666.0	2,000.0	8,666.0
612.0	6,666.0	4,000.0	10,666.0
613.0	6,666.0	7,000.0	13,666.0
614.0	6,666.0	10,000.0	16,666.0
615.0	6,666.0	14,000.0	20,666.0
616.0	6,666.0	19,000.0	25,666.0
617.0	6,666.0	24,000.0	30,666.0
618.0	6,666.0	31,000.0	37,666.0
619.0	6,666.0	37,500.0	44,166.0
620.0	6,666.0	45,500.0	52,166.0
621.0	6,666.0	54,000.0	60,666.0

Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Knightville's "ExistingOps" operational zones, which consist of zones of Surcharge (630 ft), Flood Control (610 ft), Conservation (481-505 ft), and Inactive zone (480 ft).

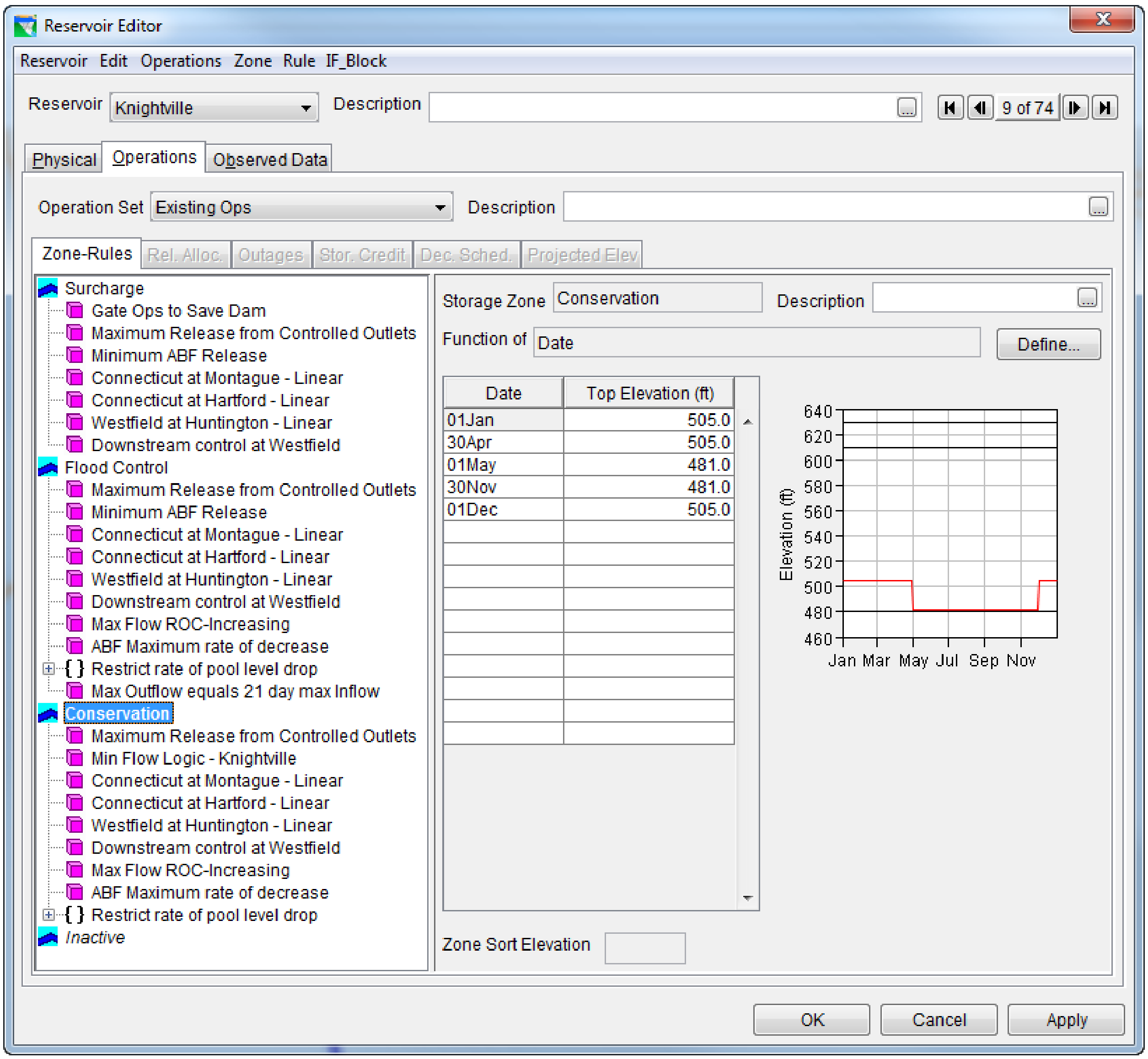


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

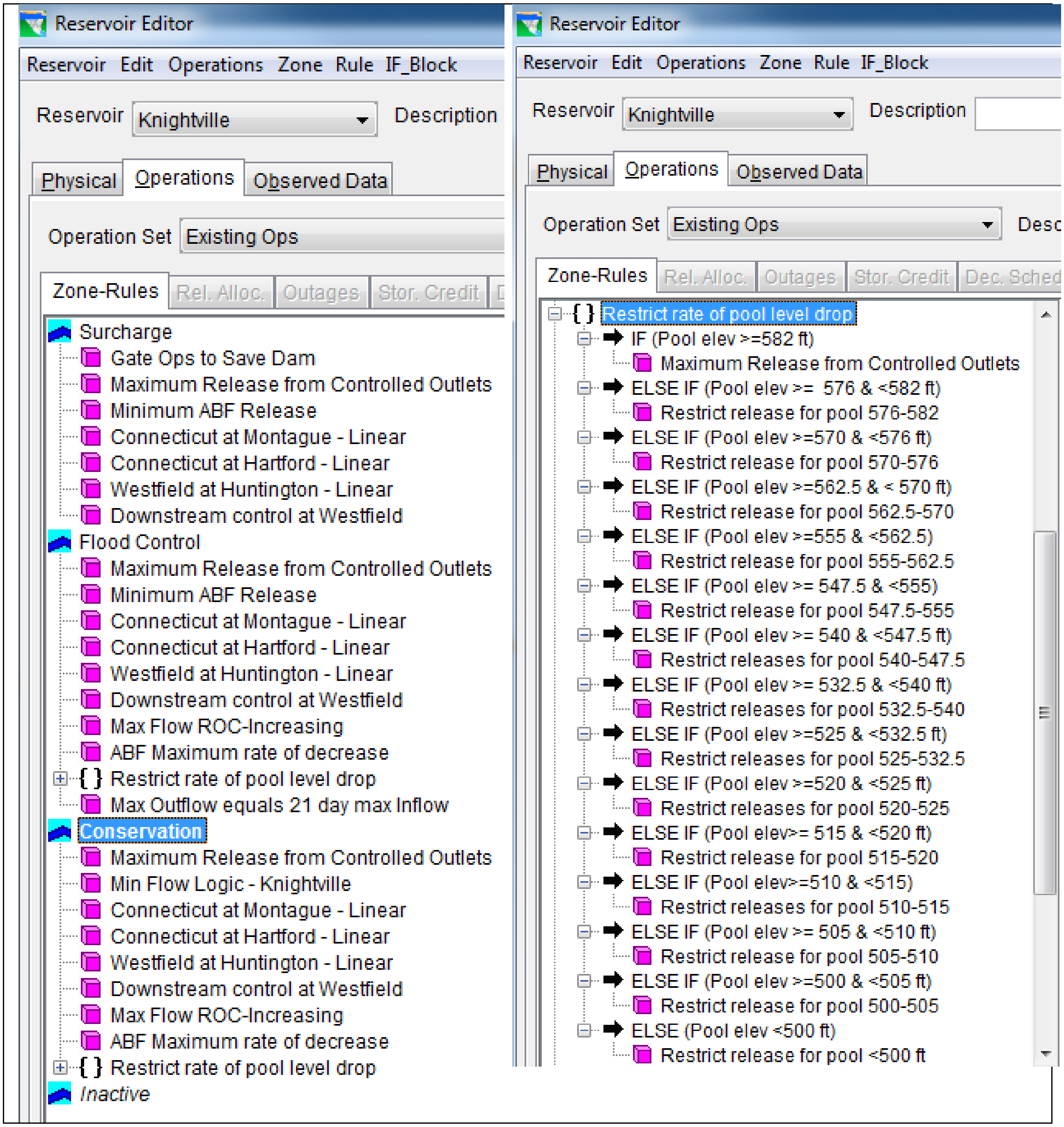


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Gate Ops to Save Dam

Figure 7 shows the content of "Gate Ops to Save Dam" rule. This rule represents the maximum allowable release from Slide gates as a function of pool elevation when the pool is in Surcharge zone.

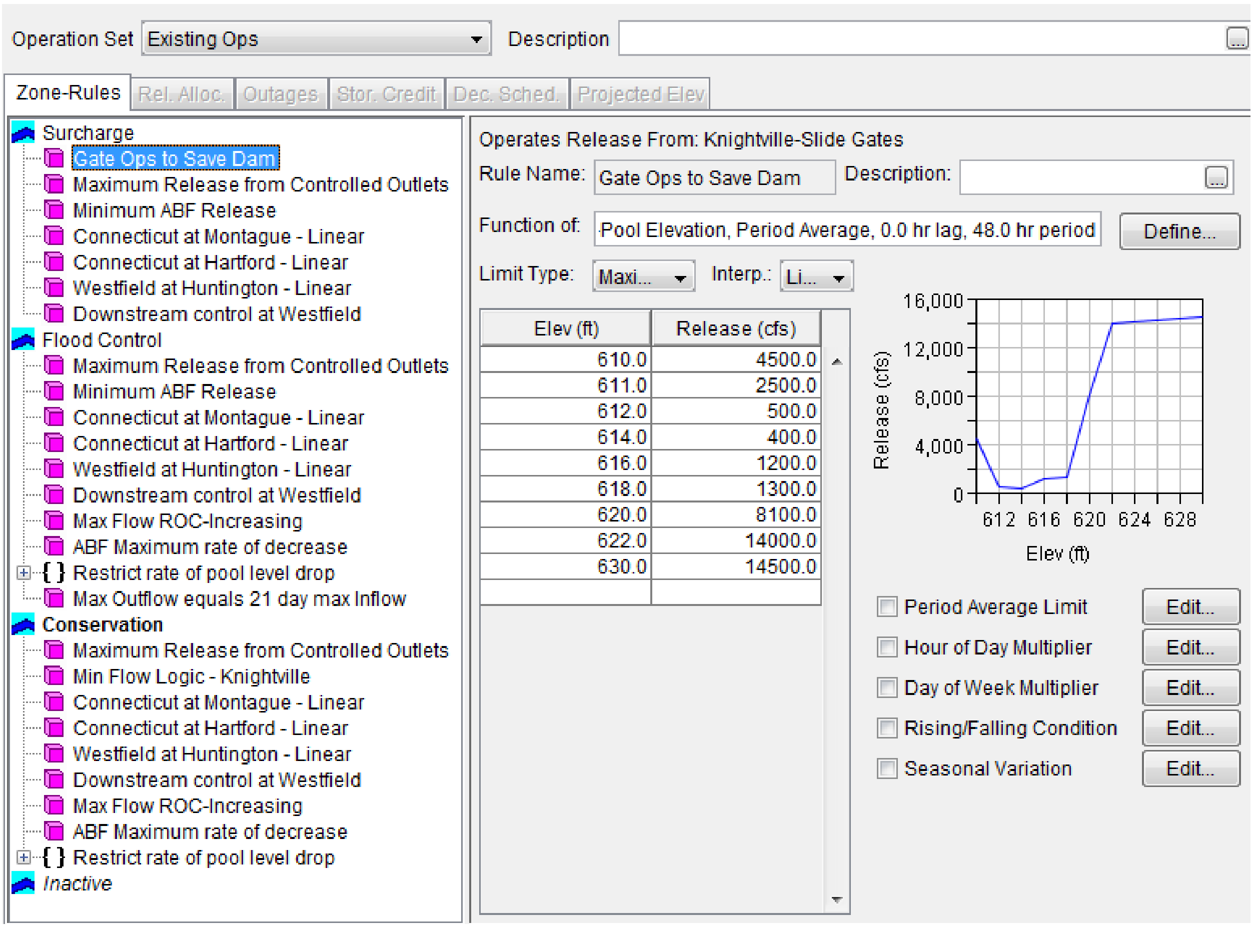


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet –Gate Ops to Save Dam

2. *Maximum Release from Controlled Outlets*

Figure 8 shows the content of "Maximum Release from Controlled Outlets" rule. This rule represents the maximum allowable release from Slide gates.

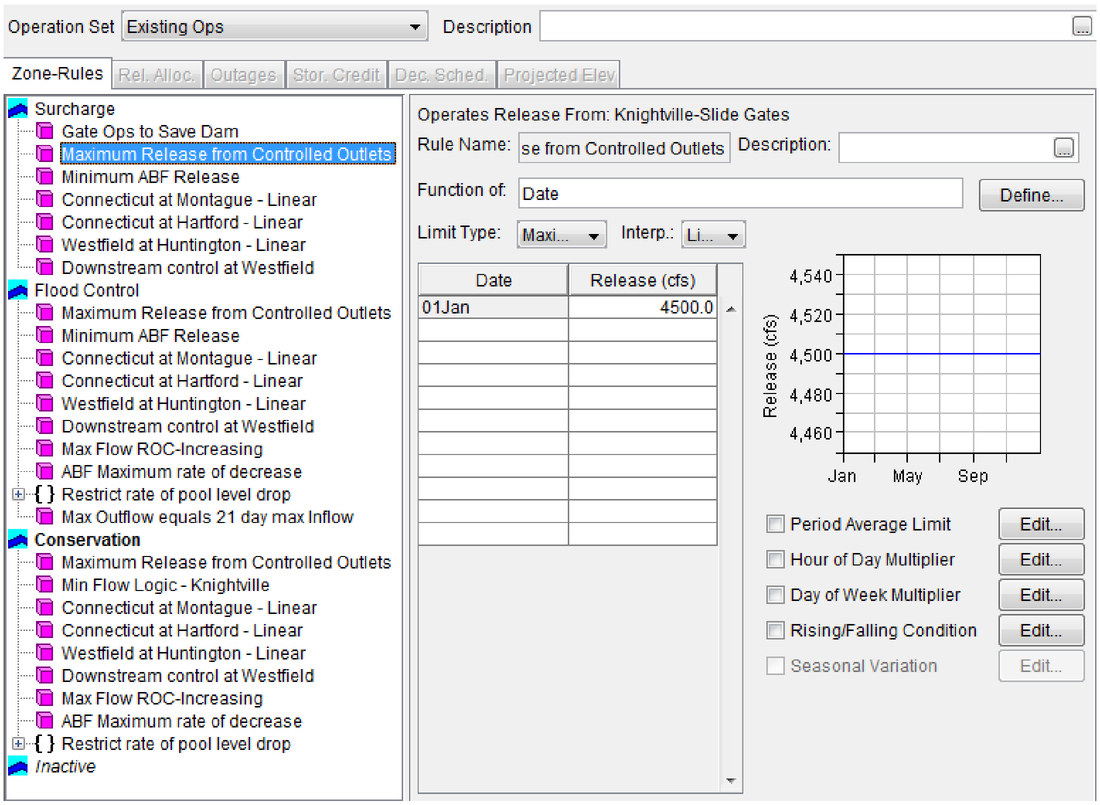


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maximum Release from Controlled Outlets

3. *Minimum ABF Release*

Figure 9 shows the content of “Minimum ABF Release” rule. This rule represents the minimum required release from dam during flood control operations.

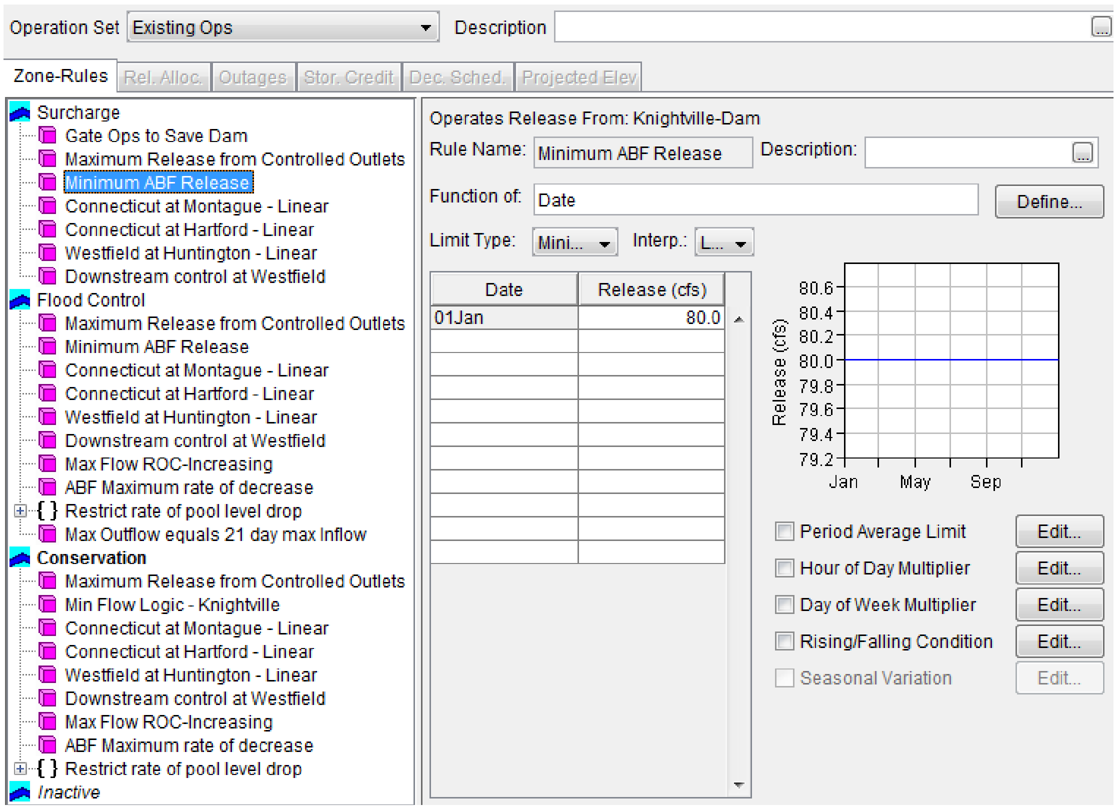


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet –Minimum ABF Release

4. Connecticut at Montague-Linear

Figure 10 shows the content of “Connecticut at Montague-Linear” rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montague. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

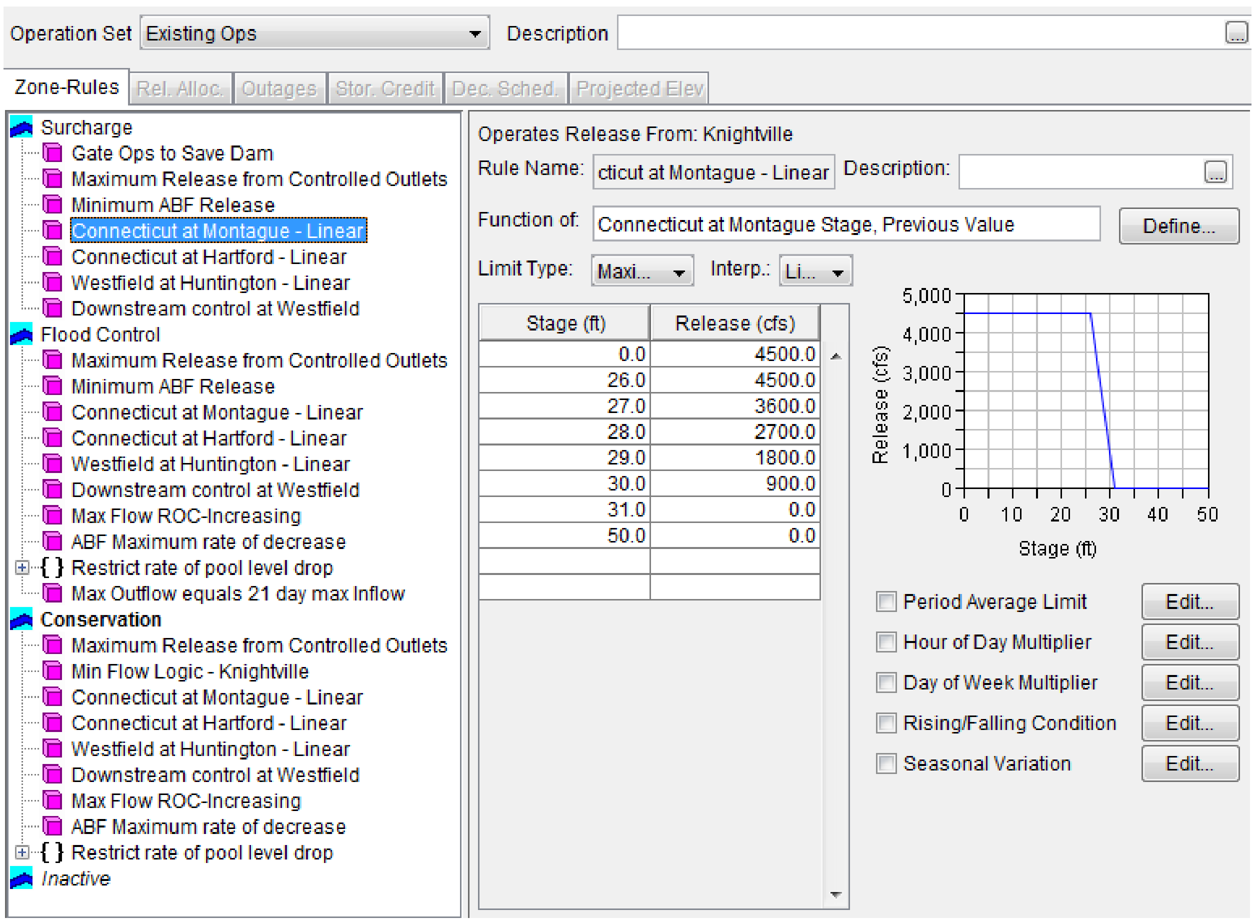


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague-Linear

5. *Connecticut at Hartford-Linear*

Figure 11 shows the content of “Connecticut at Hartford-Linear” rule. This rule represents the maximum allowable release from dam as a function of previous day stage at Hartford. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

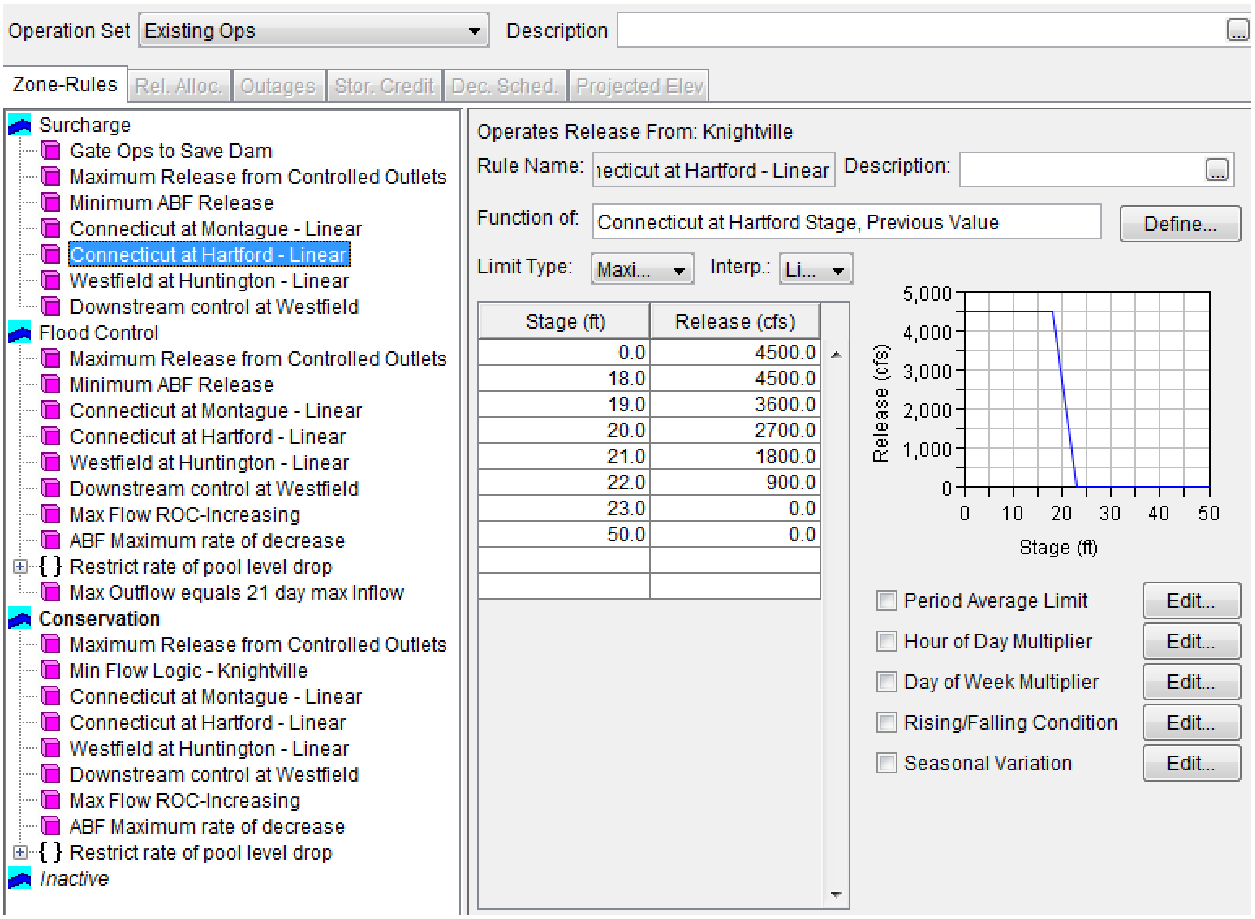


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague-Linear

6. *Westfield at Huntington-Linear*

Figure 12 shows the content of "Westfield at Huntington-Linear" rule. This rule represents the maximum allowable release from dam as a function of previous day stage at Huntington. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

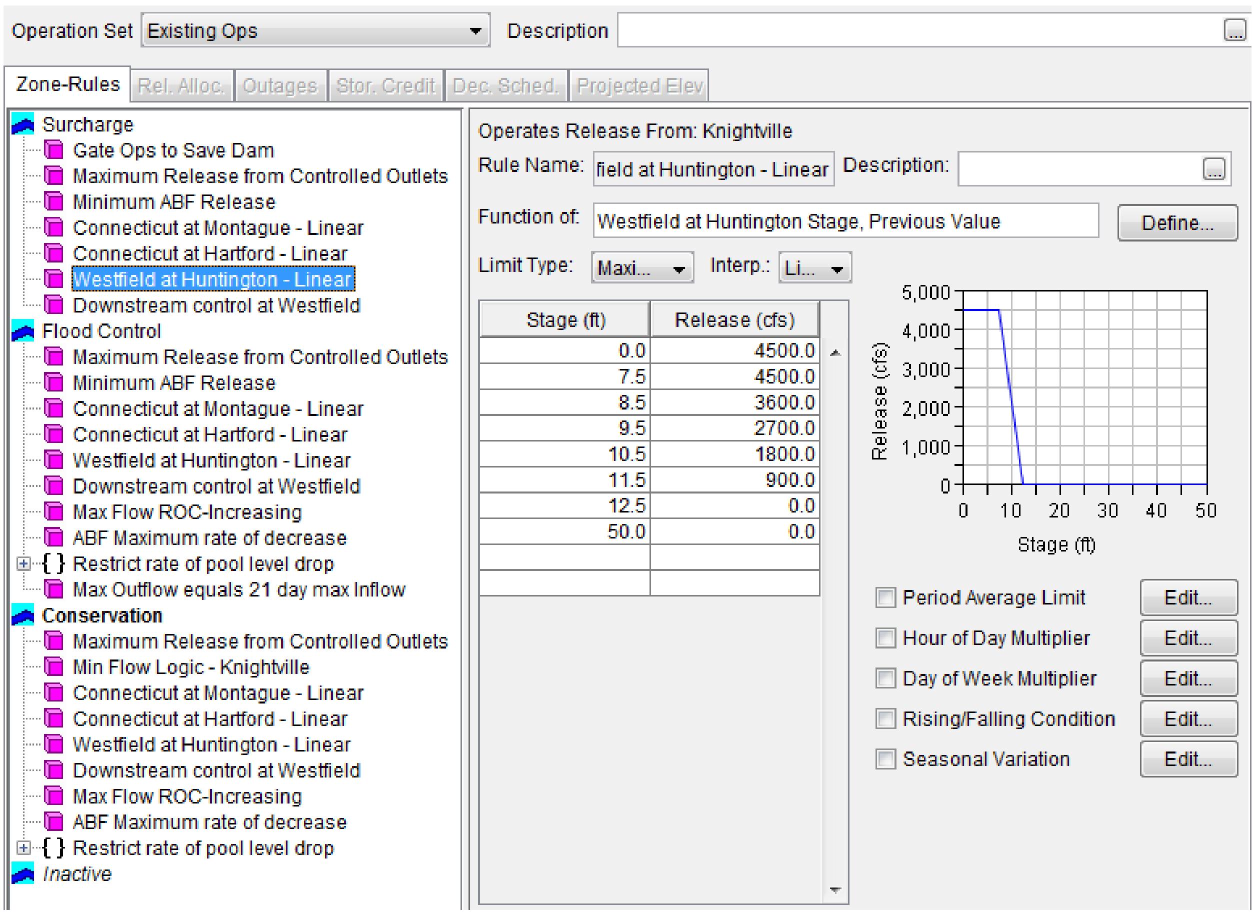


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Westfield at Huntington-Linear

7. *Downstream control at Westfield*

Figure 13 shows the content of "Downstream control at Westfield" rule. This rule represents the maximum allowable flow at the downstream point Westfield at Huntington.

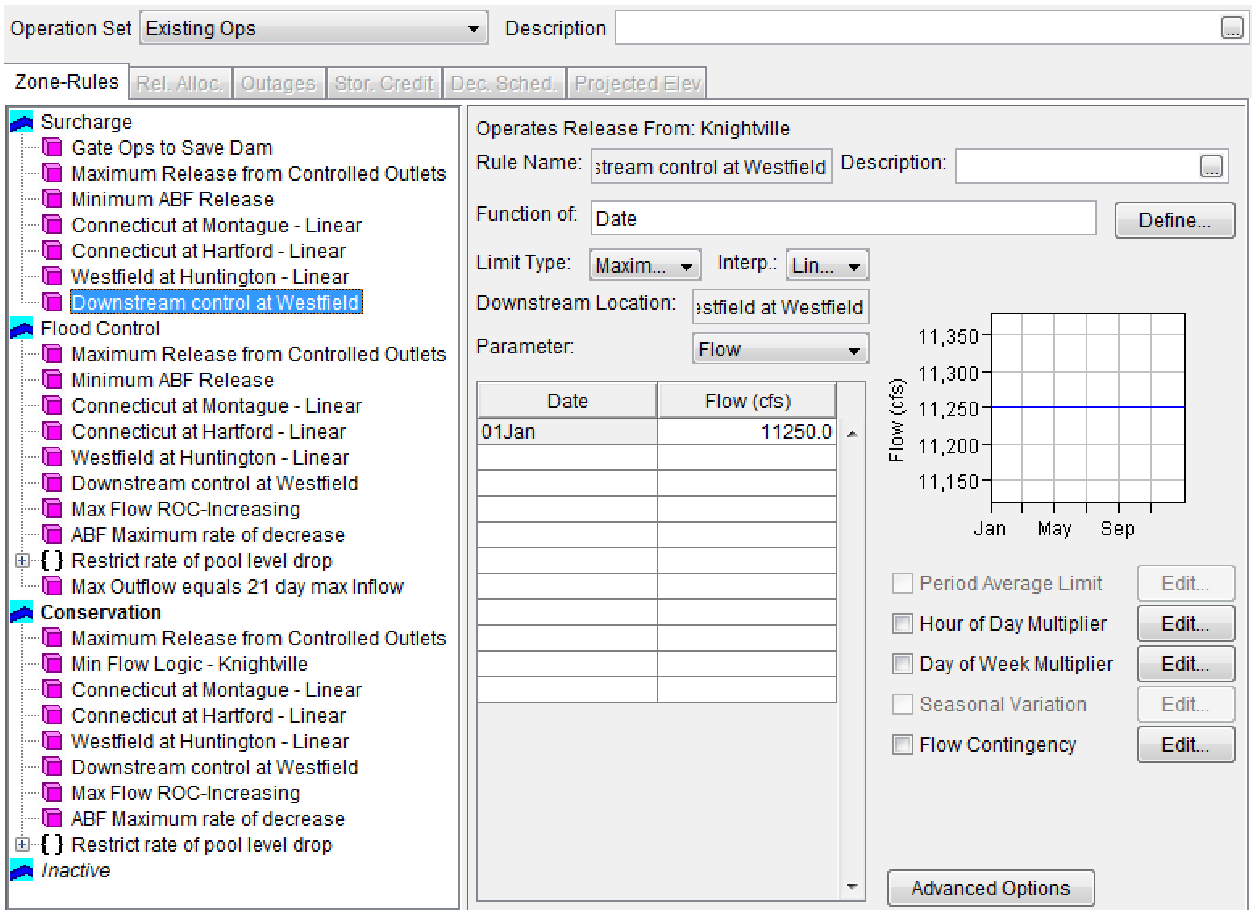


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet –Downstream controlat Westfield

8. Max Flow ROC-Increasing

Figure 14 shows the content of "Max Flow ROC-Increasing" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Knightville dam.

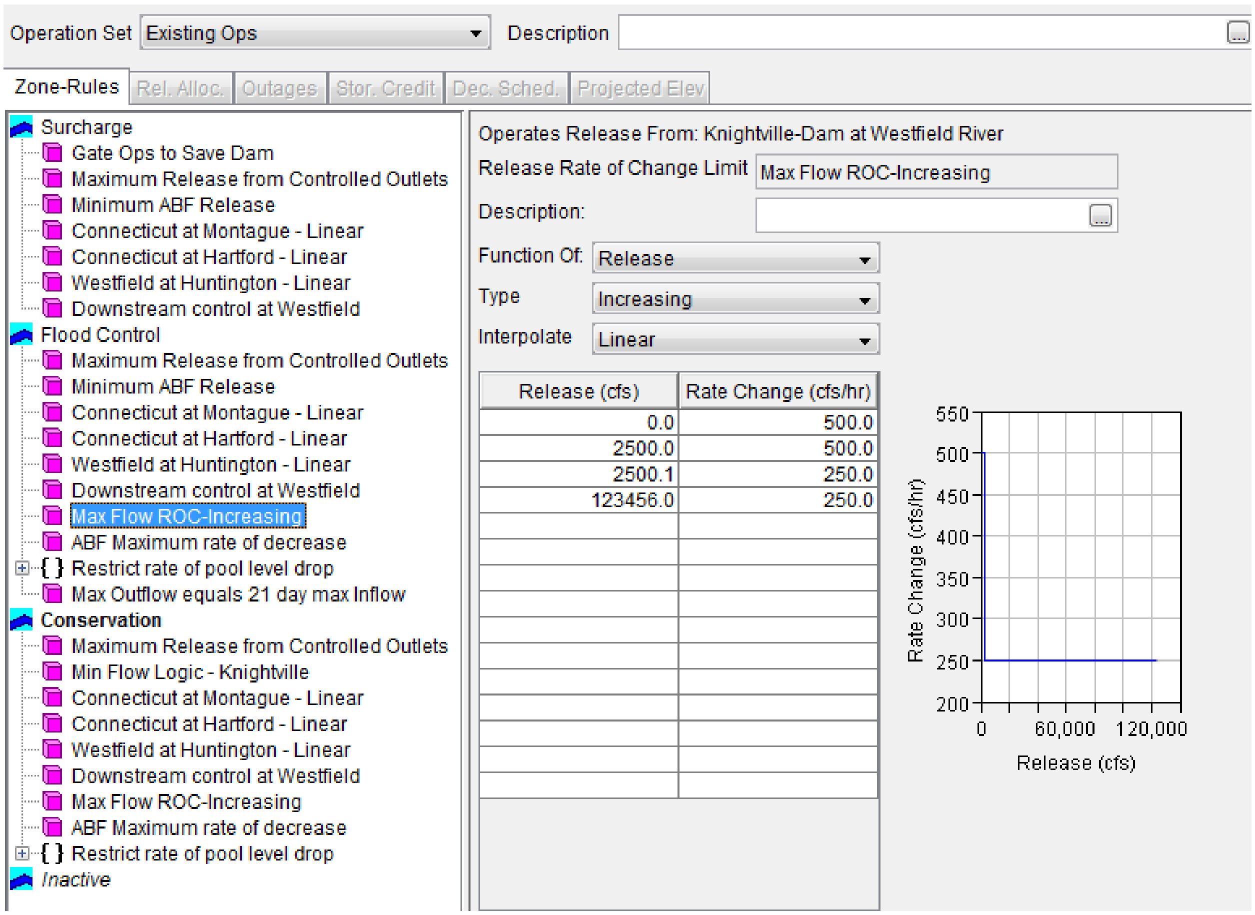


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max Flow ROC-Increasing

9. *ABF Maximum rate of decrease*

Figure 15 shows the content of “ABF Maximum rate of decrease” rule. This rule shows the maximum allowable decreasing release rate of change.

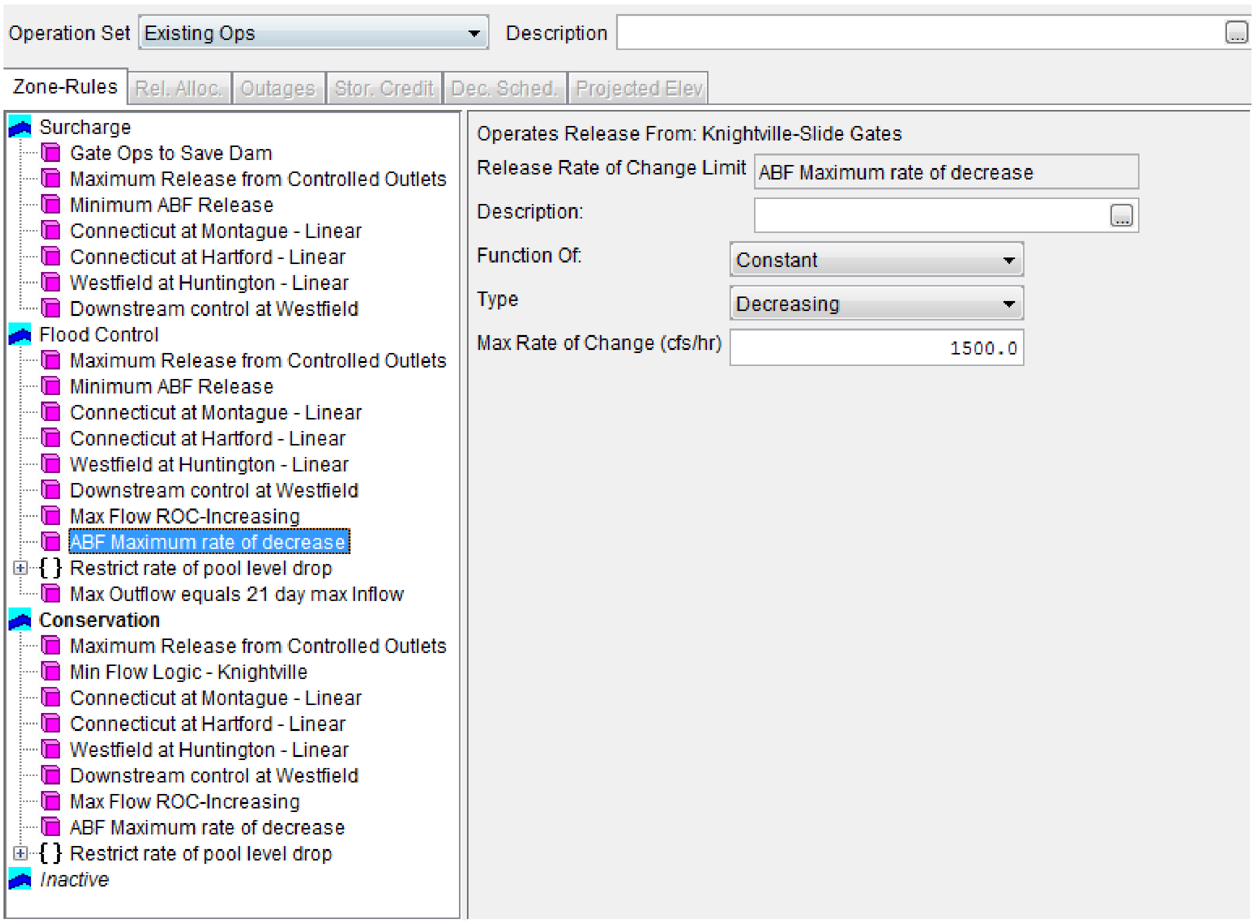
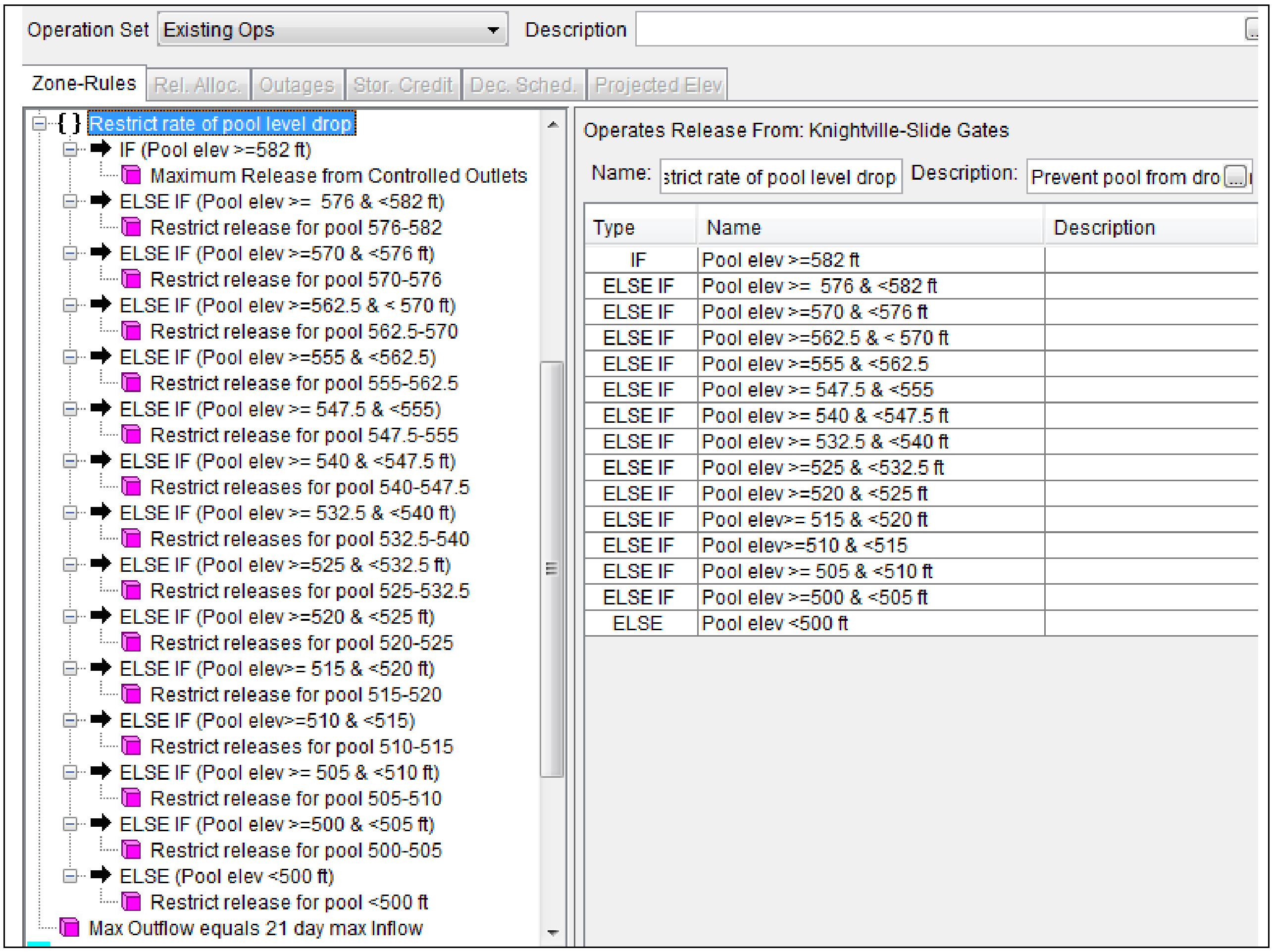
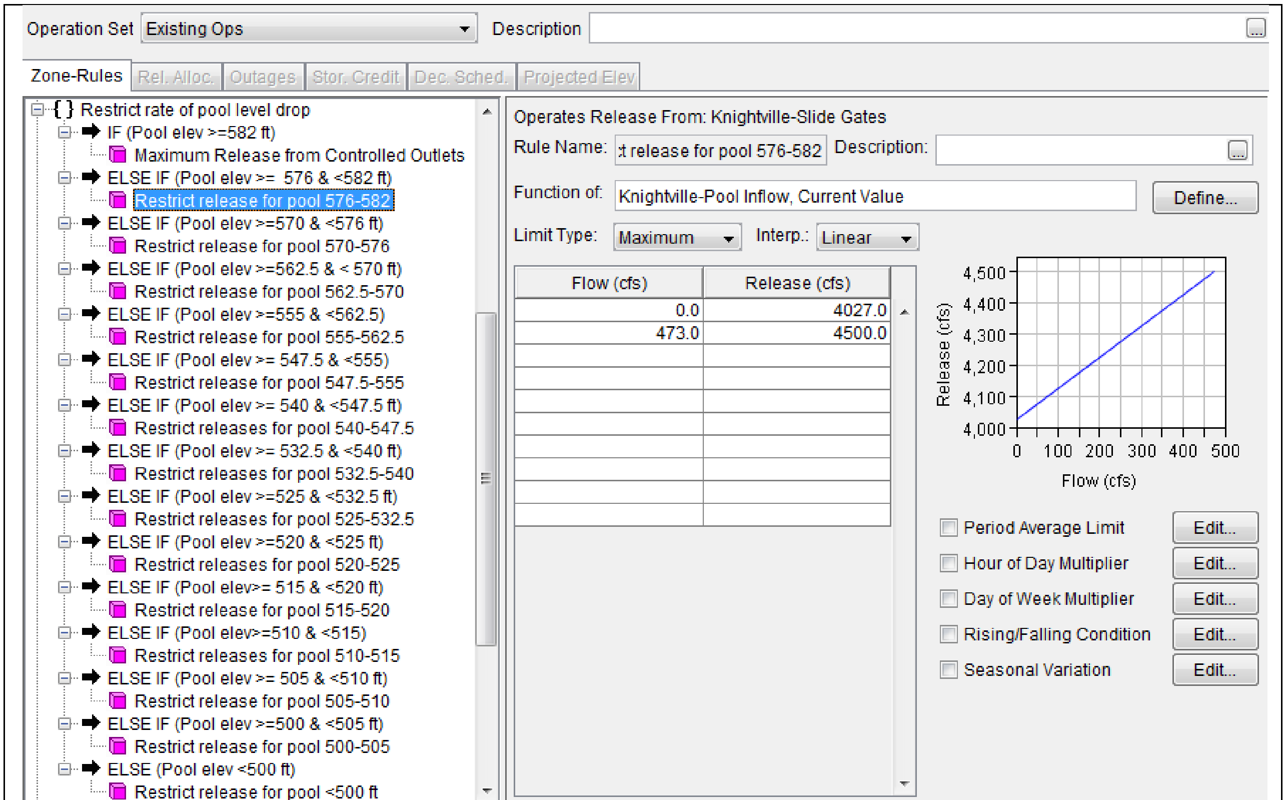


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet –ABF Maximum rate of decrease

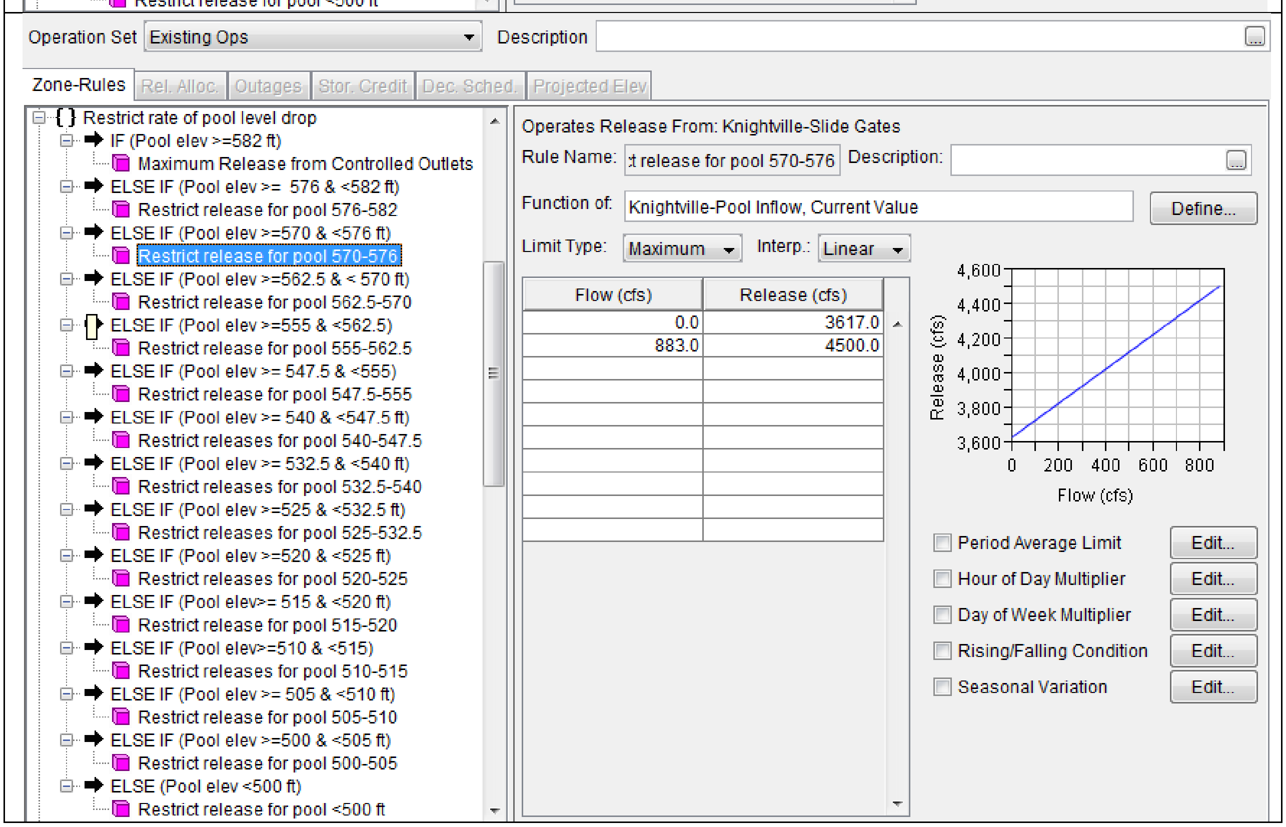
10. Restrict rate of pool level drop

Figure 16 shows the content of "Restrict rate of pool level drop" rule. It shows the maximum allowable release as a function of Inflow for different ranges of pool elevations.

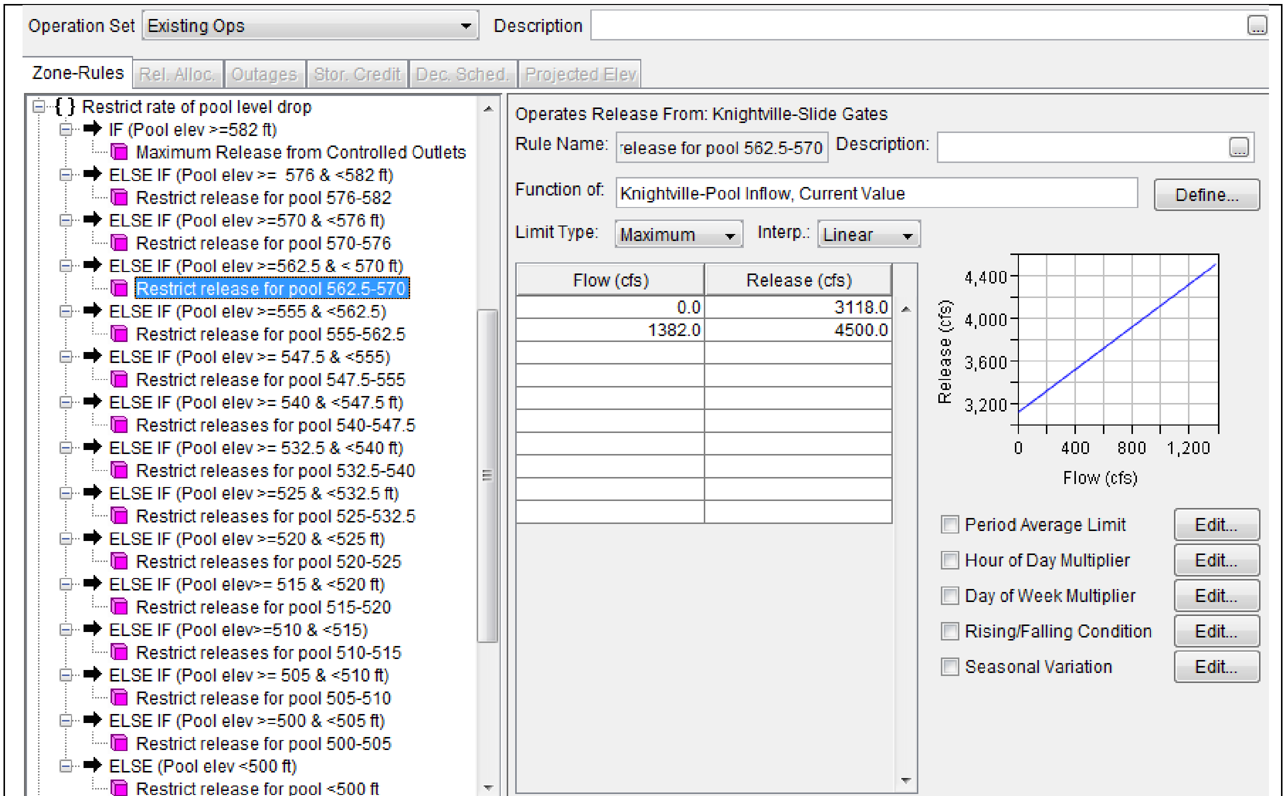


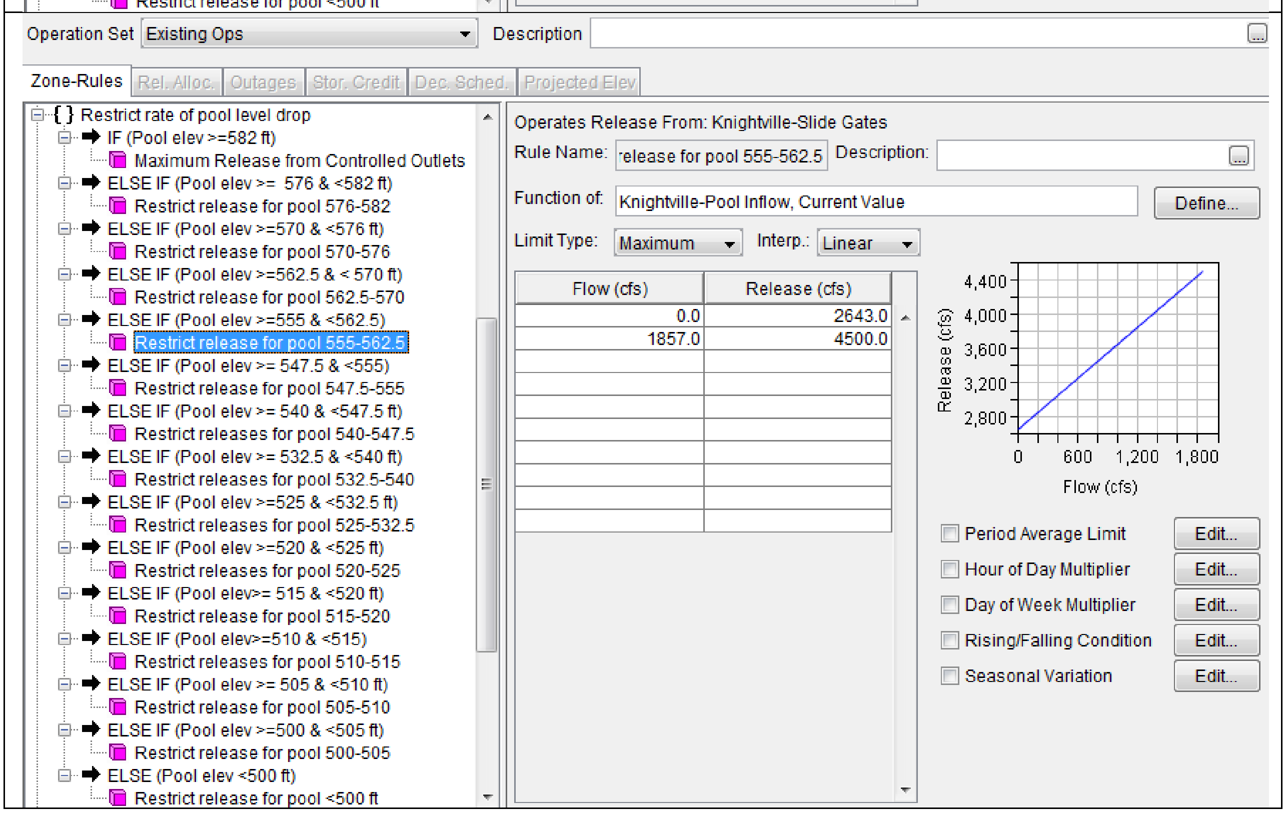


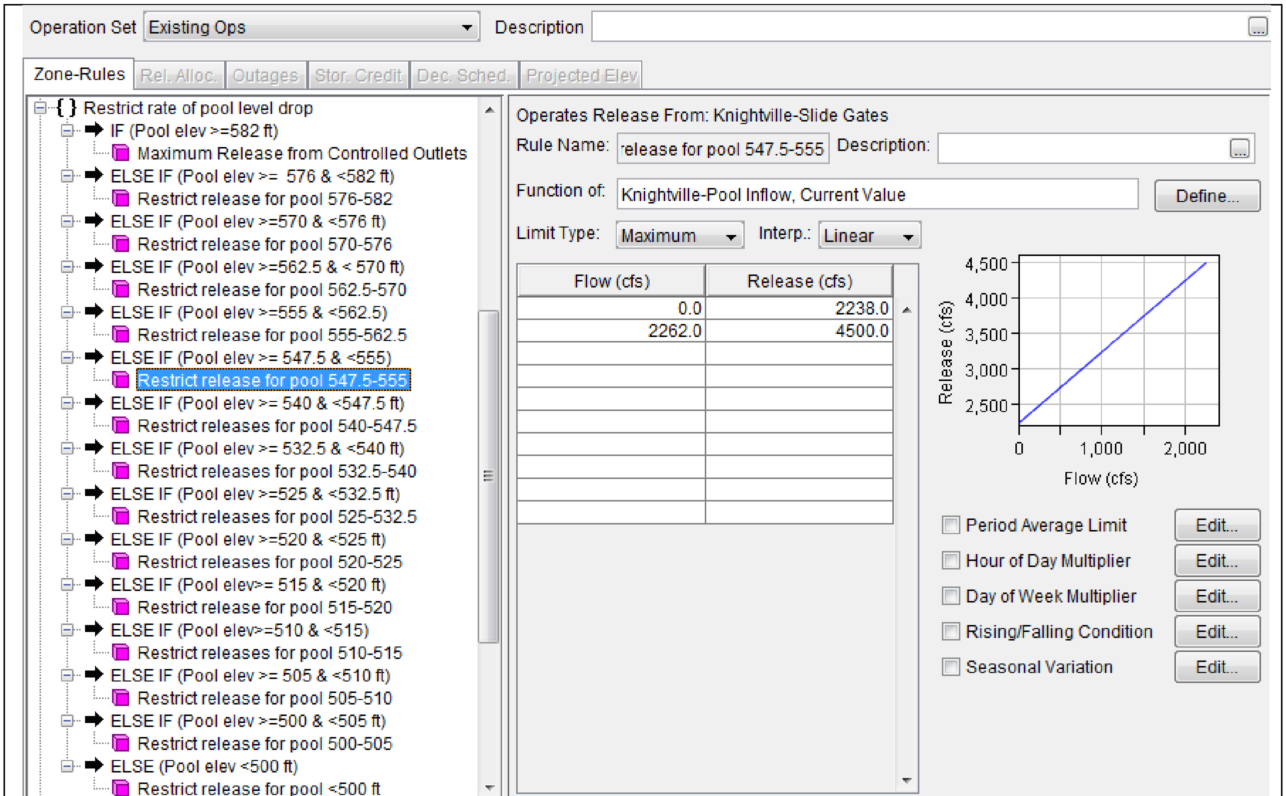
Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: :t release for pool 576-582
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
4027.0
473.0
4500.0
4,500
4,400
4,300
4,200
4,100
4,000
Release (cfs)
0
100
200
300
400
500
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

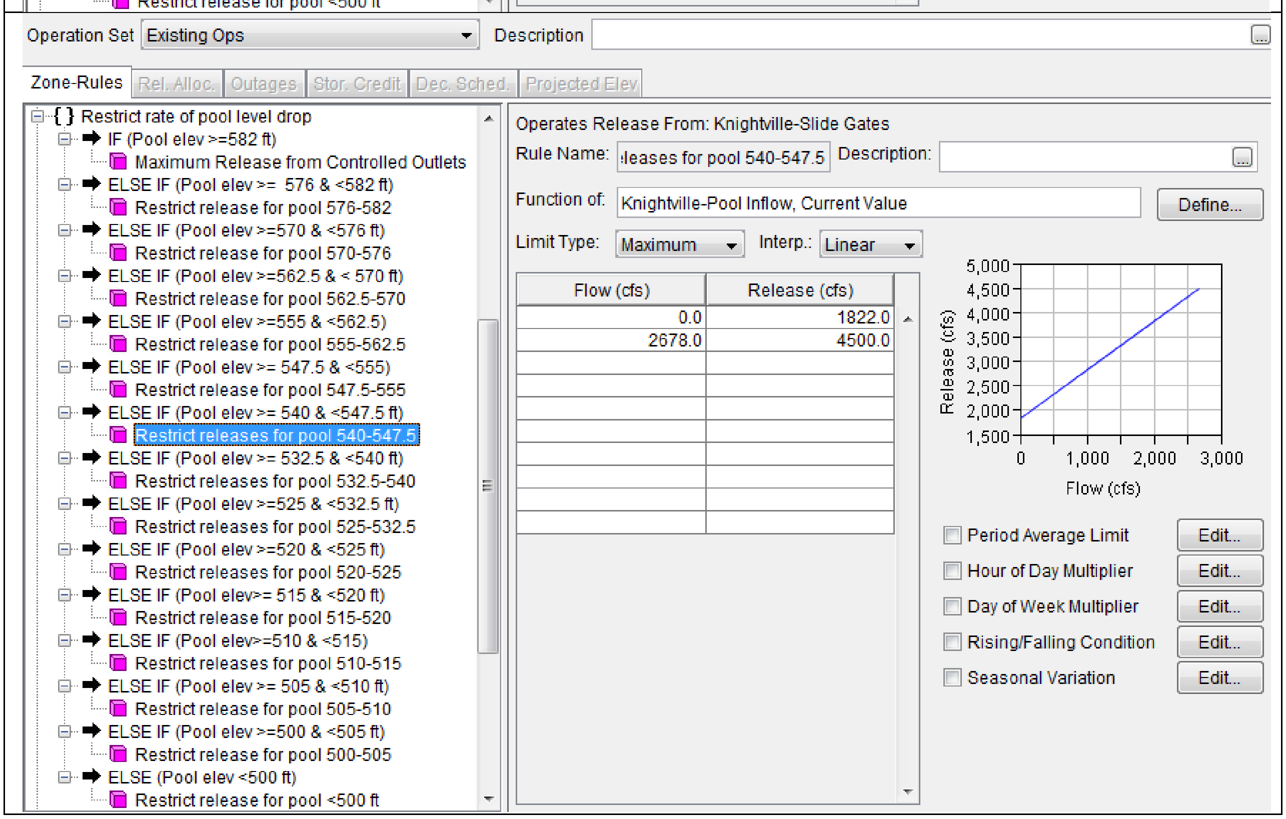


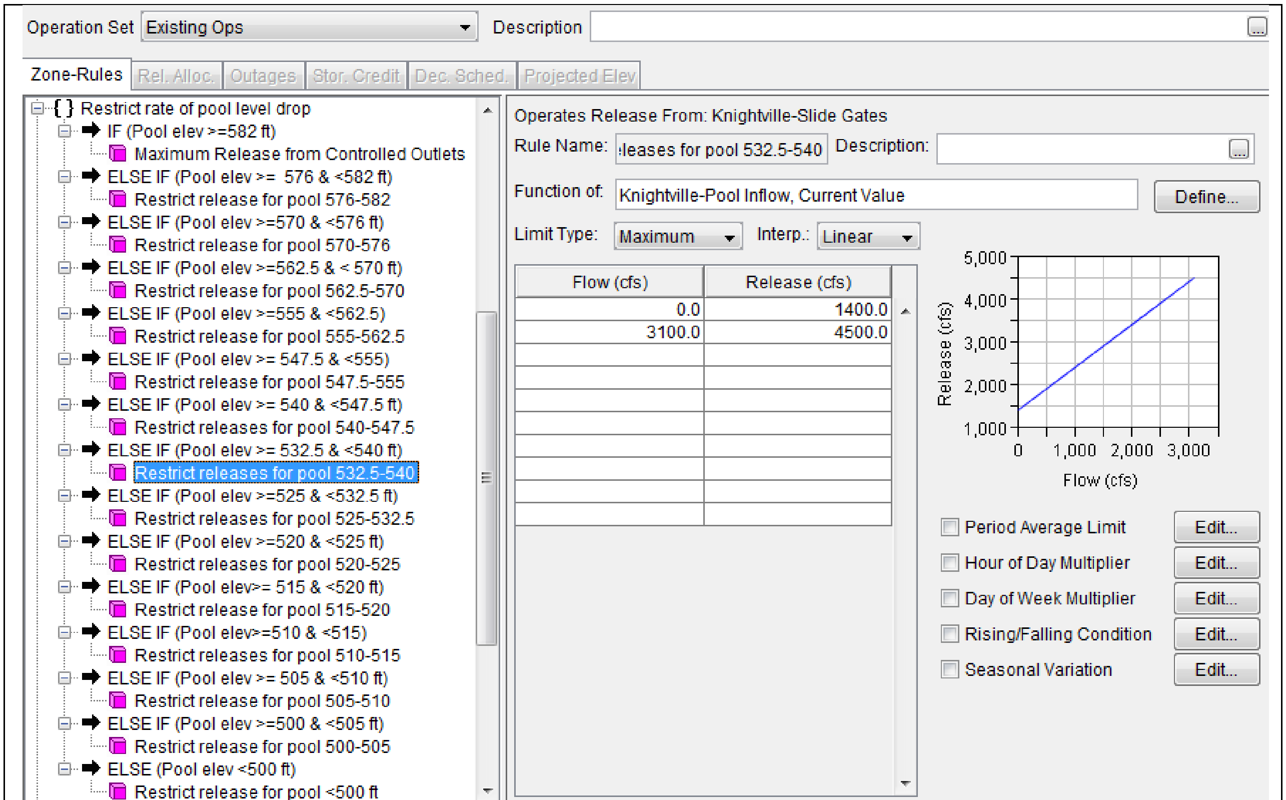
Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: :t release for pool 570-576
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
3617.0
883.0
4500.0
4,600
4,400
4,200
4,000
3,800
3,600
Release (cfs)
0
200
400
600
800
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

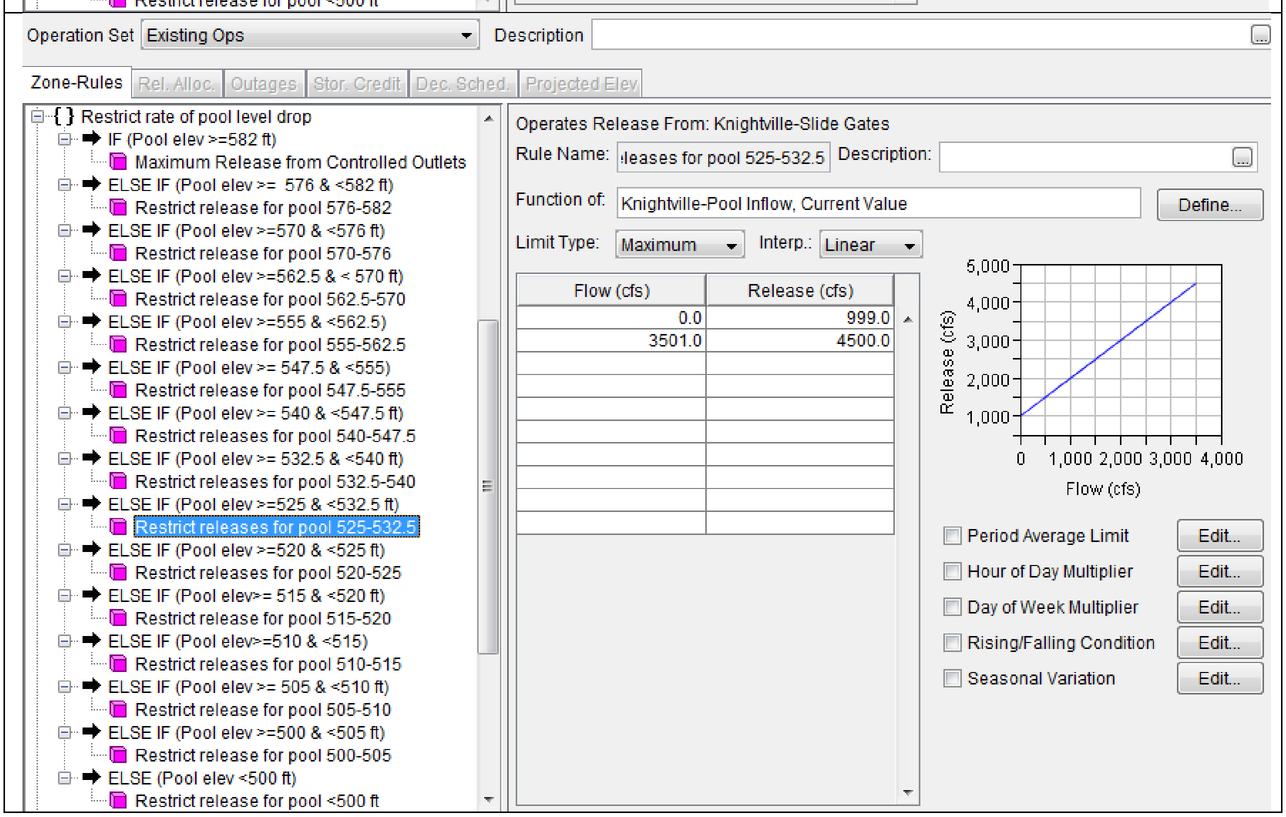

Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: elease for pool 562.5-570
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
3118.0
1382.0
4500.0
4,400
4,000
3,600
3,200
Release (cfs)
0
400
800
1,200
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

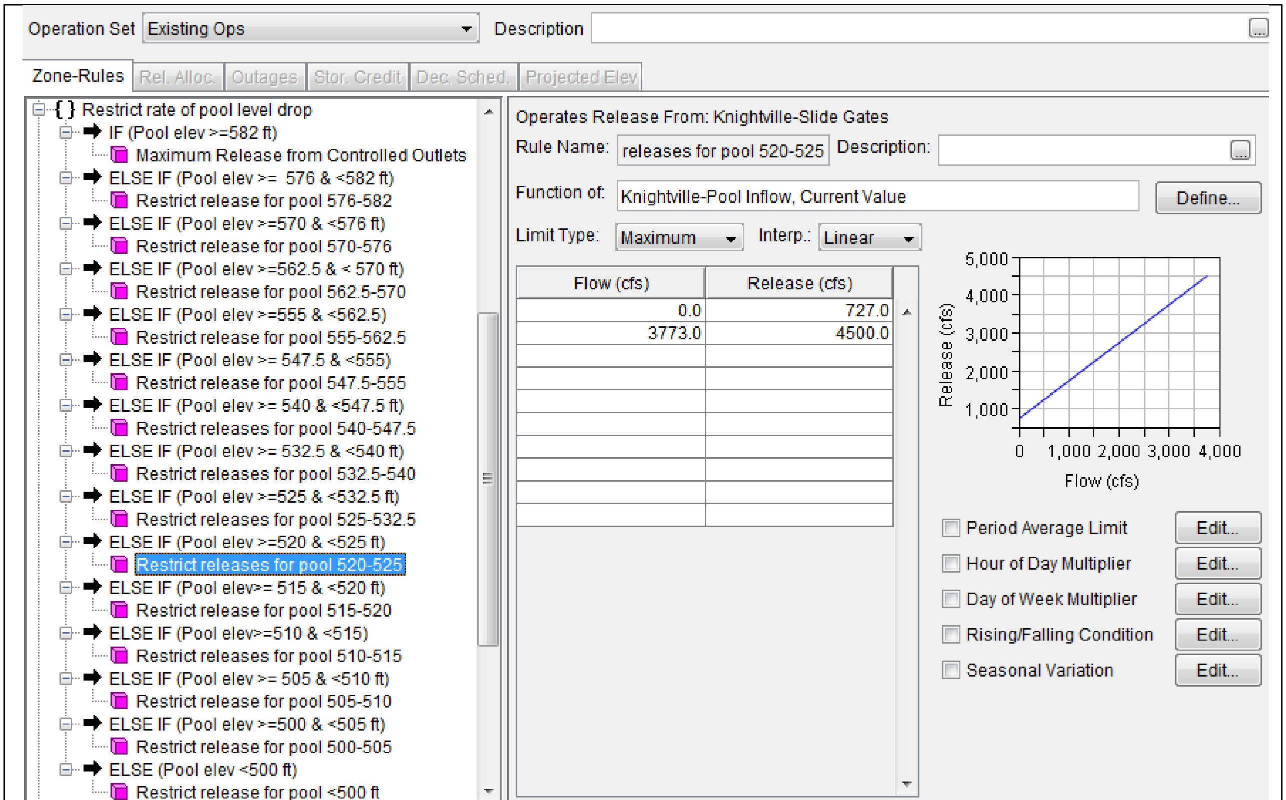

Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: elease for pool 555-562.5
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
2643.0
1857.0
4500.0
4,400
4,000
3,600
3,200
2,800
Release (cfs)
0
600
1,200
1,800
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

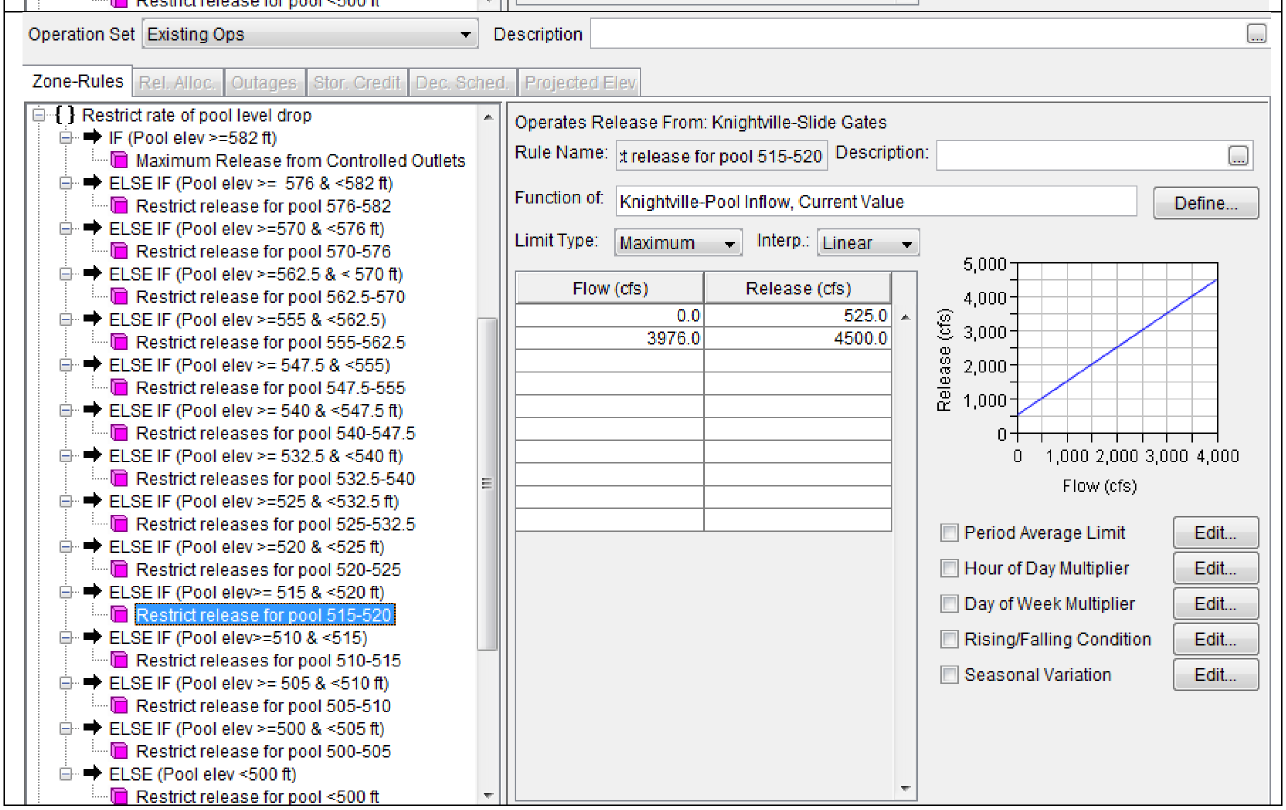

Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: release for pool 547.5-555
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs) | Release (cfs)
0.0 | 2238.0
2262.0 | 4500.0
Release (cfs)
4,500
4,000
3,500
3,000
2,500
0
1,000
2,000
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

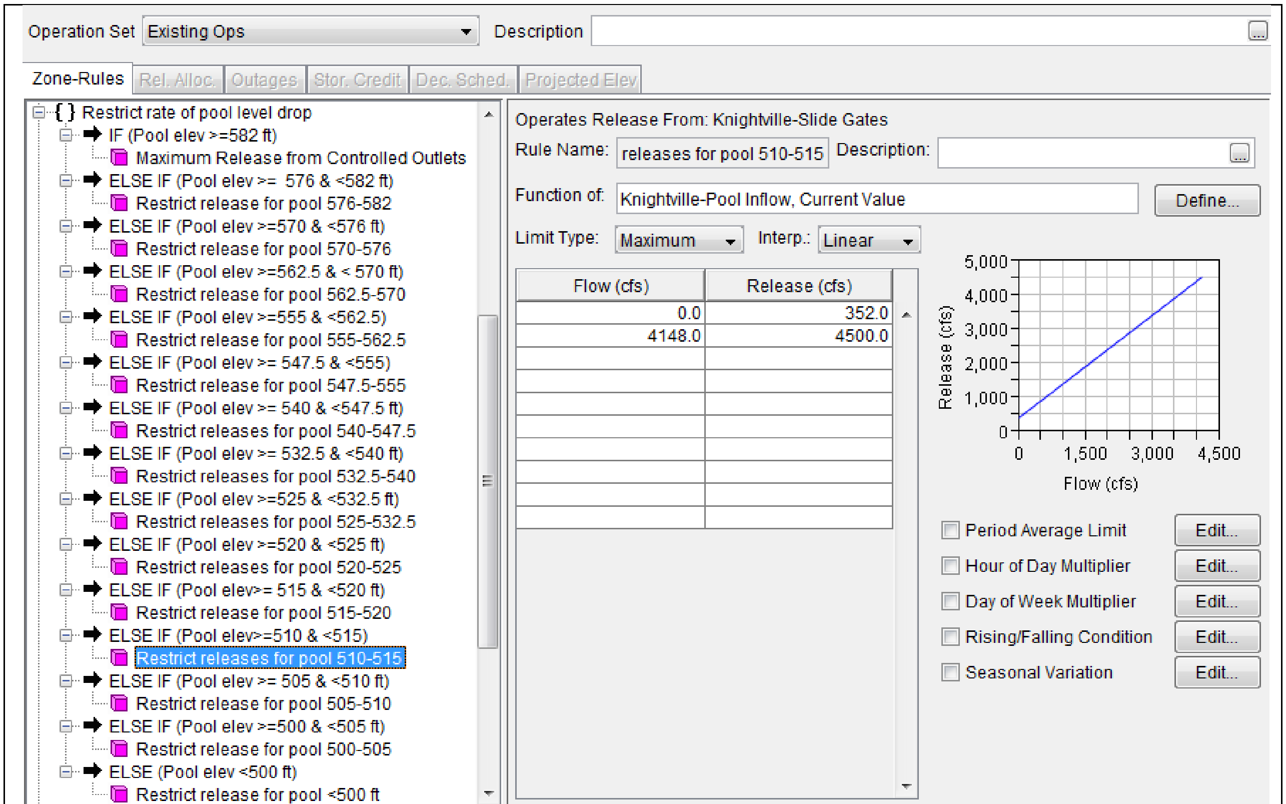

Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: leases for pool 540-547.5
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs) | Release (cfs)
0.0 | 1822.0
2678.0 | 4500.0
Release (cfs)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
0
1,000
2,000
3,000
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

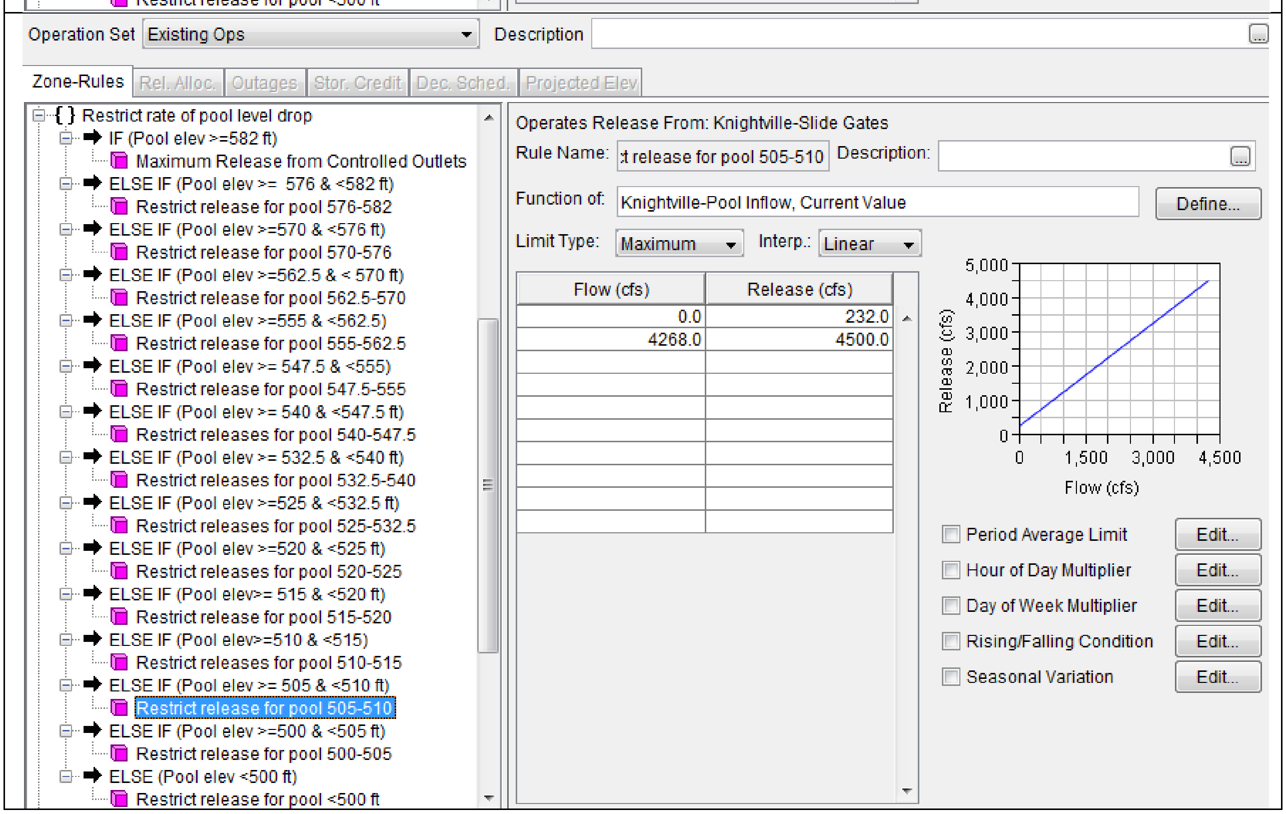

Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: leases for pool 532.5-540
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
1400.0
3100.0
4500.0
5,000
4,000
3,000
2,000
1,000
0
1,000
2,000
3,000
Release (cfs)
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: leases for pool 525-532.5
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
999.0
3501.0
4500.0
5,000
4,000
3,000
2,000
1,000
0
1,000
2,000
3,000
4,000
Release (cfs)
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: releases for pool 520-525
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs) | Release (cfs)
0.0 | 727.0
3773.0 | 4500.0
Release (cfs)
5,000
4,000
3,000
2,000
1,000
0
1,000
2,000
3,000
4,000
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: :t release for pool 515-520
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs) | Release (cfs)
0.0 | 525.0
3976.0 | 4500.0
Release (cfs)
5,000
4,000
3,000
2,000
1,000
0
1,000
2,000
3,000
4,000
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: releases for pool 510-515
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
352.0
4148.0
4500.0
5,000
4,000
3,000
2,000
1,000
0
Release (cfs)
0
1,500
3,000
4,500
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool elev >=582 ft)
Maximum Release from Controlled Outlets
ELSE IF (Pool elev >= 576 & <582 ft)
Restrict release for pool 576-582
ELSE IF (Pool elev >=570 & <576 ft)
Restrict release for pool 570-576
ELSE IF (Pool elev >=562.5 & < 570 ft)
Restrict release for pool 562.5-570
ELSE IF (Pool elev >=555 & <562.5)
Restrict release for pool 555-562.5
ELSE IF (Pool elev >= 547.5 & <555)
Restrict release for pool 547.5-555
ELSE IF (Pool elev >= 540 & <547.5 ft)
Restrict releases for pool 540-547.5
ELSE IF (Pool elev >= 532.5 & <540 ft)
Restrict releases for pool 532.5-540
ELSE IF (Pool elev >=525 & <532.5 ft)
Restrict releases for pool 525-532.5
ELSE IF (Pool elev >=520 & <525 ft)
Restrict releases for pool 520-525
ELSE IF (Pool elev>= 515 & <520 ft)
Restrict release for pool 515-520
ELSE IF (Pool elev>=510 & <515)
Restrict releases for pool 510-515
ELSE IF (Pool elev >= 505 & <510 ft)
Restrict release for pool 505-510
ELSE IF (Pool elev >=500 & <505 ft)
Restrict release for pool 500-505
ELSE (Pool elev <500 ft)
Restrict release for pool <500 ft
Operates Release From: Knightville-Slide Gates
Rule Name: :t release for pool 505-510
Description:
Function of: Knightville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
232.0
4268.0
4500.0
5,000
4,000
3,000
2,000
1,000
0
Release (cfs)
0
1,500
3,000
4,500
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

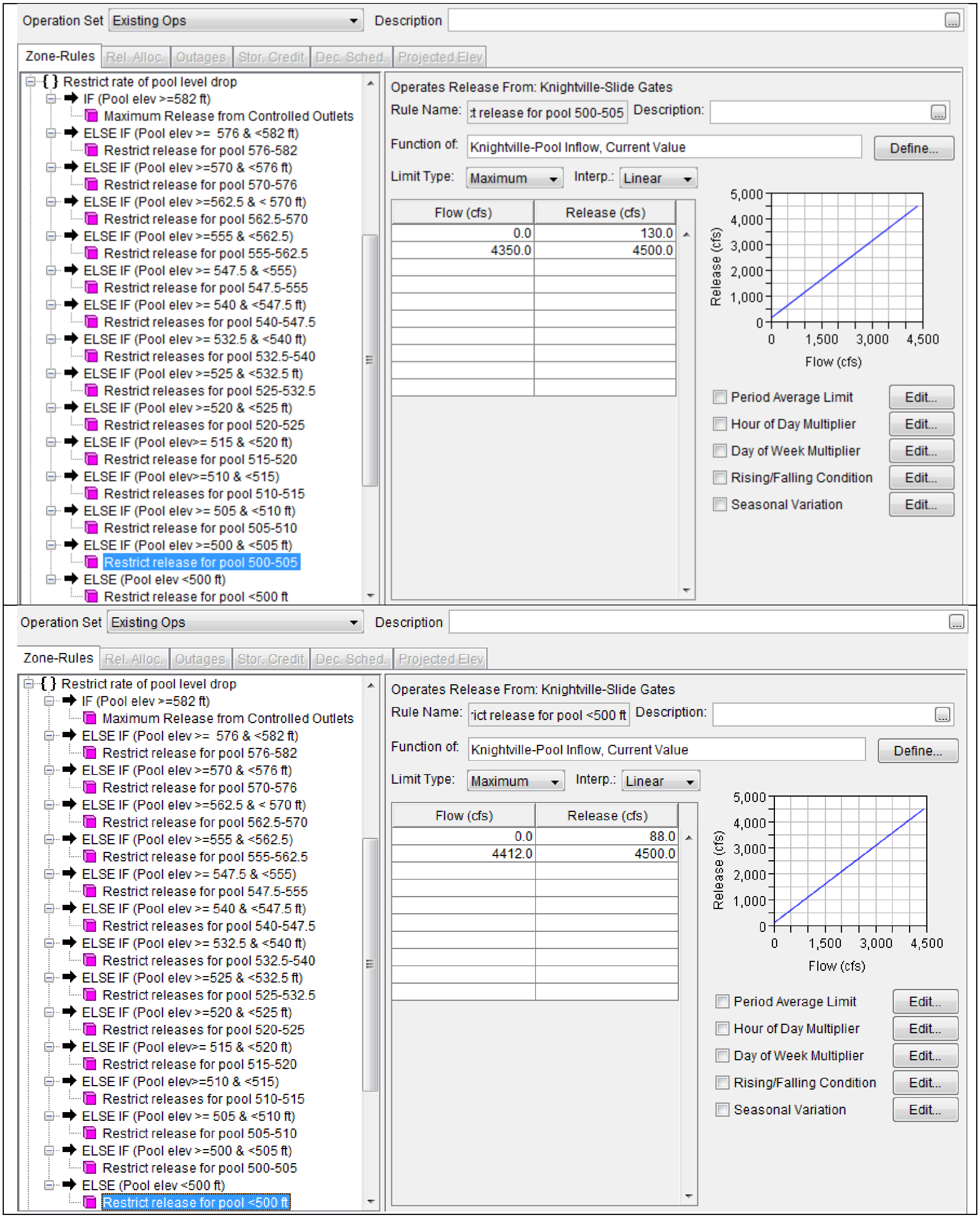


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet – Restrict rate of pool level drop

11. Max Outflow equals 21 day max Inflow

Figure 17 shows the content of "Max Outflow equals 21 day max Inflow" rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

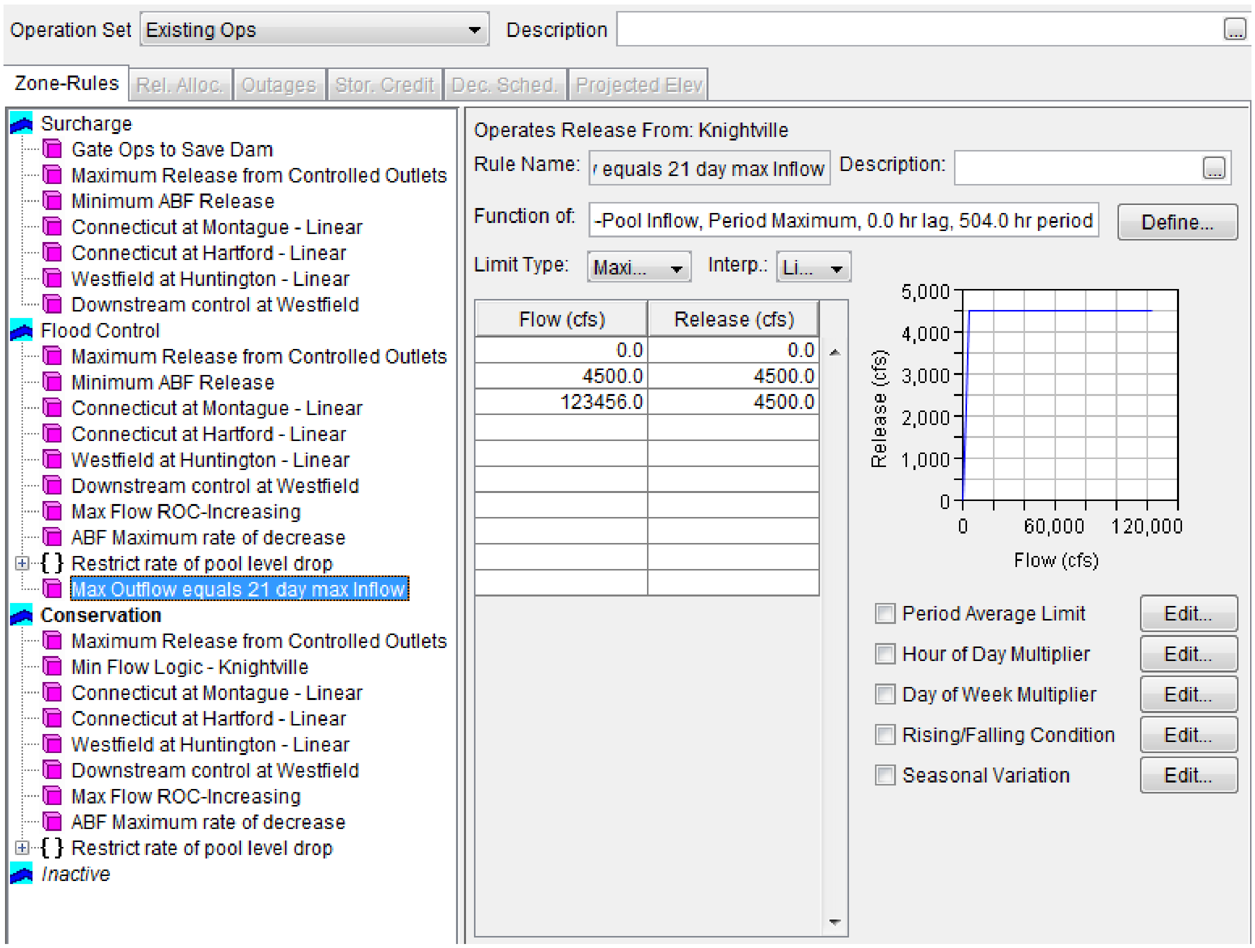


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals 21 day max Inflow

12. Min Flow Logic - Knightville

Figure 18 shows the content of “Min Flow Logic - Knightville” rule. This rule describes required seasonal minimum flows from controlled outlets as a function of inflow at Knightville.

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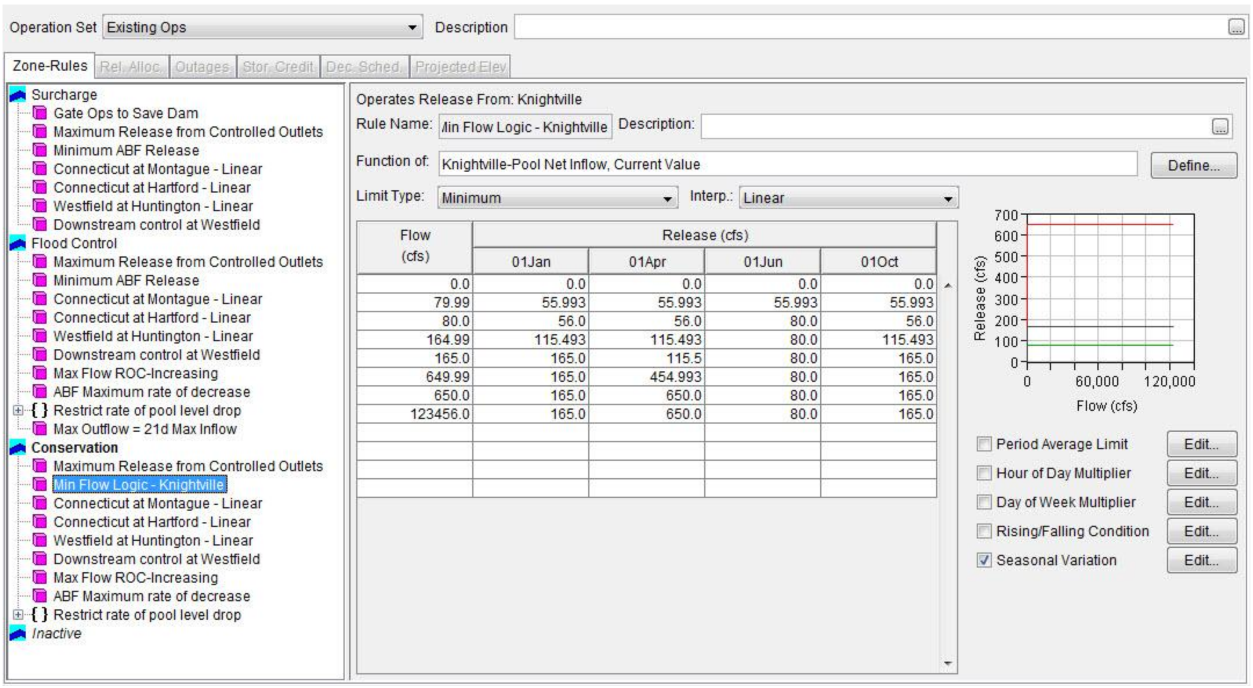


Figure 18: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic - Knightville

Lake Francis

I. Overview

Lake Francis (Murphy) dam is located in the town of Pittsburg, NH. It is owned and operated by TransCanada Hydro Northeast Inc. as a storage reservoir to make releases to its downstream hydro facilities.

Figure 1 shows the location of Lake Francis as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Lake Francis.

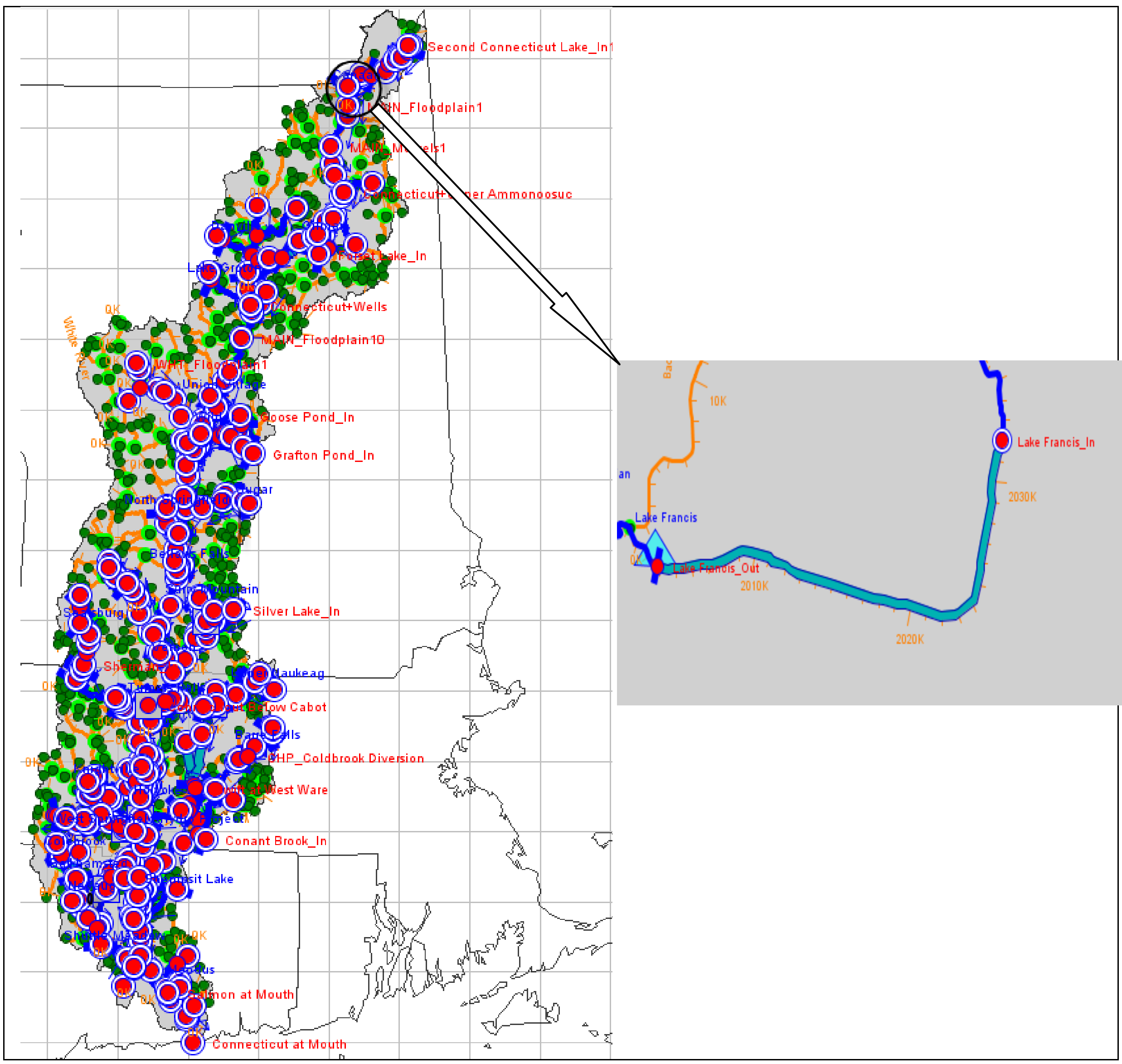


Figure 1: HEC-ResSim Map Display Showing Location of First Connecticut Dam

Figure 2: Aerial photo of Lake Francis

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[50]. The dam consists of seven types of outlets: (1) uncontrolled Bay#1, (2) uncontrolled Bay#5(flashboards all in), (3) uncontrolled Bay#5(flashboards partly cleared), (4) uncontrolled Bay#2, (5) uncontrolled Bay#3, (6) uncontrolled Bay#4 , and (7) controlled Tunnel discharge as shown in Figure 4.

[50] Data provided by TransCanada

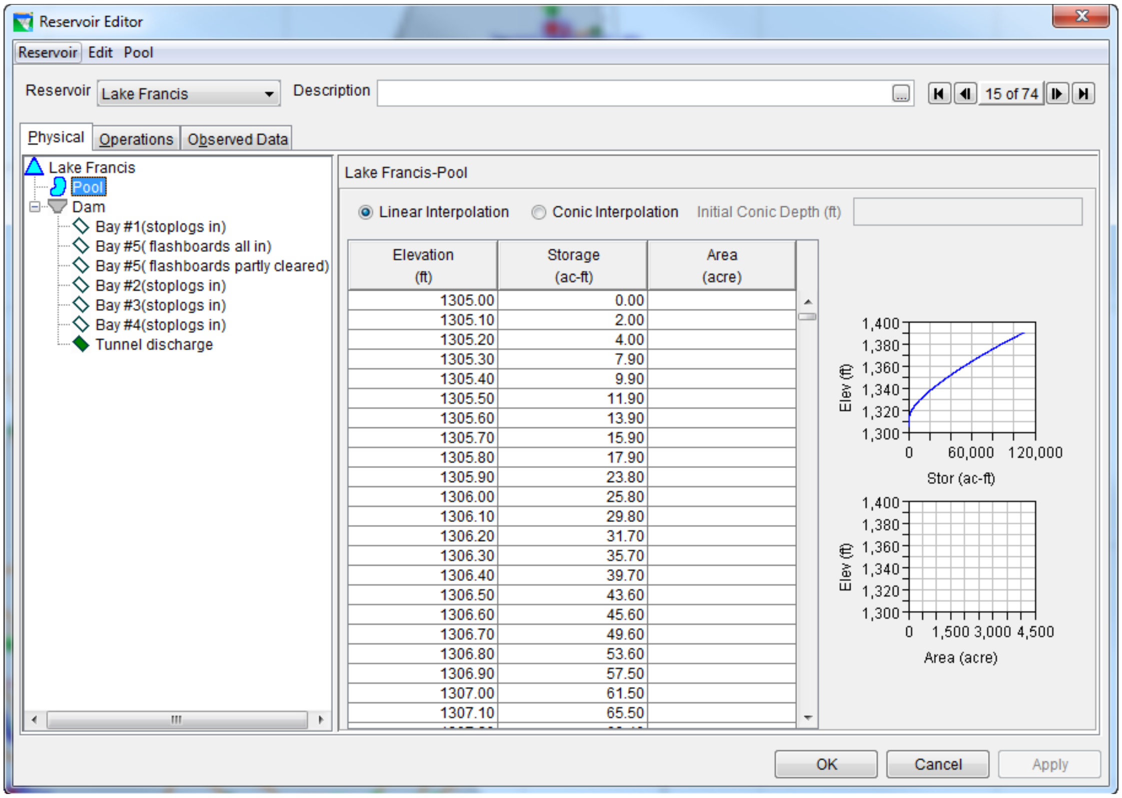


Figure 3: Reservoir Editor: Physical Tab -- Pool

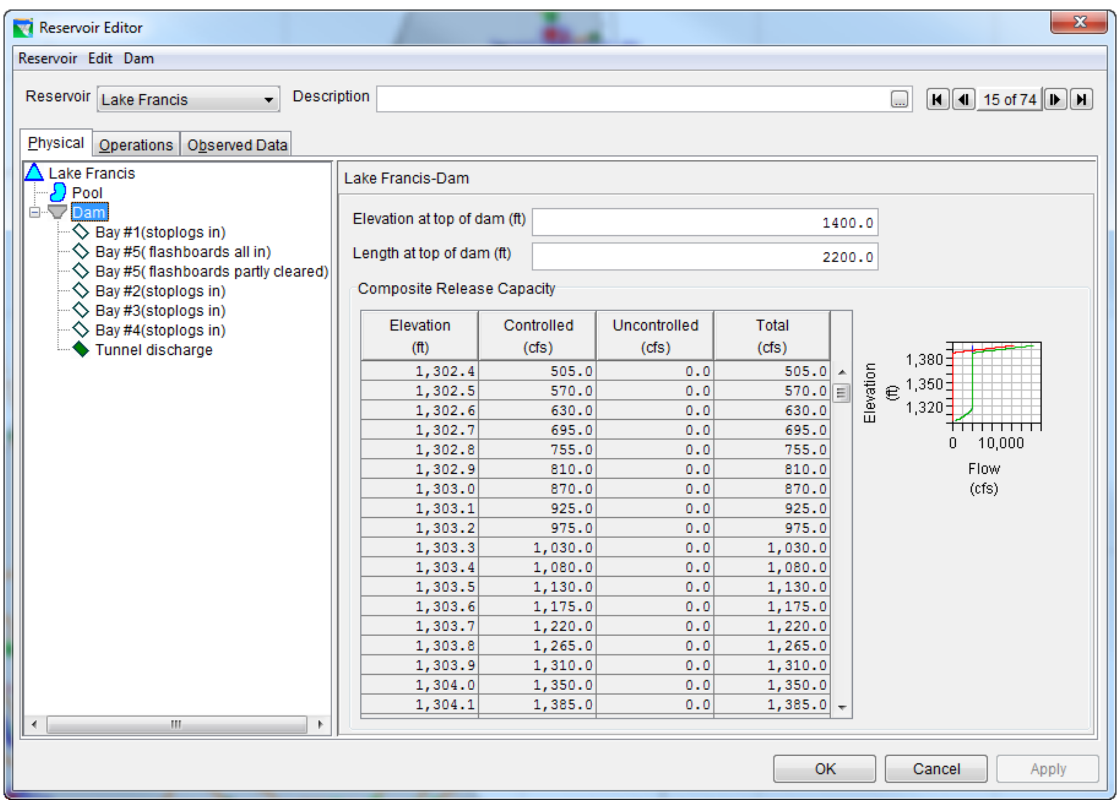


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of First Connecticut Dam's "Existing Ops" operational zones, which consist of zones of Top of dam (1400 ft), Below Top of dam (1399 ft), Conservation (1340.492-1379.249 ft), and Inactive zone (1305 ft). The Conservation Pool Elevation curve was created from 10 years of weekly average pool elevation[1].

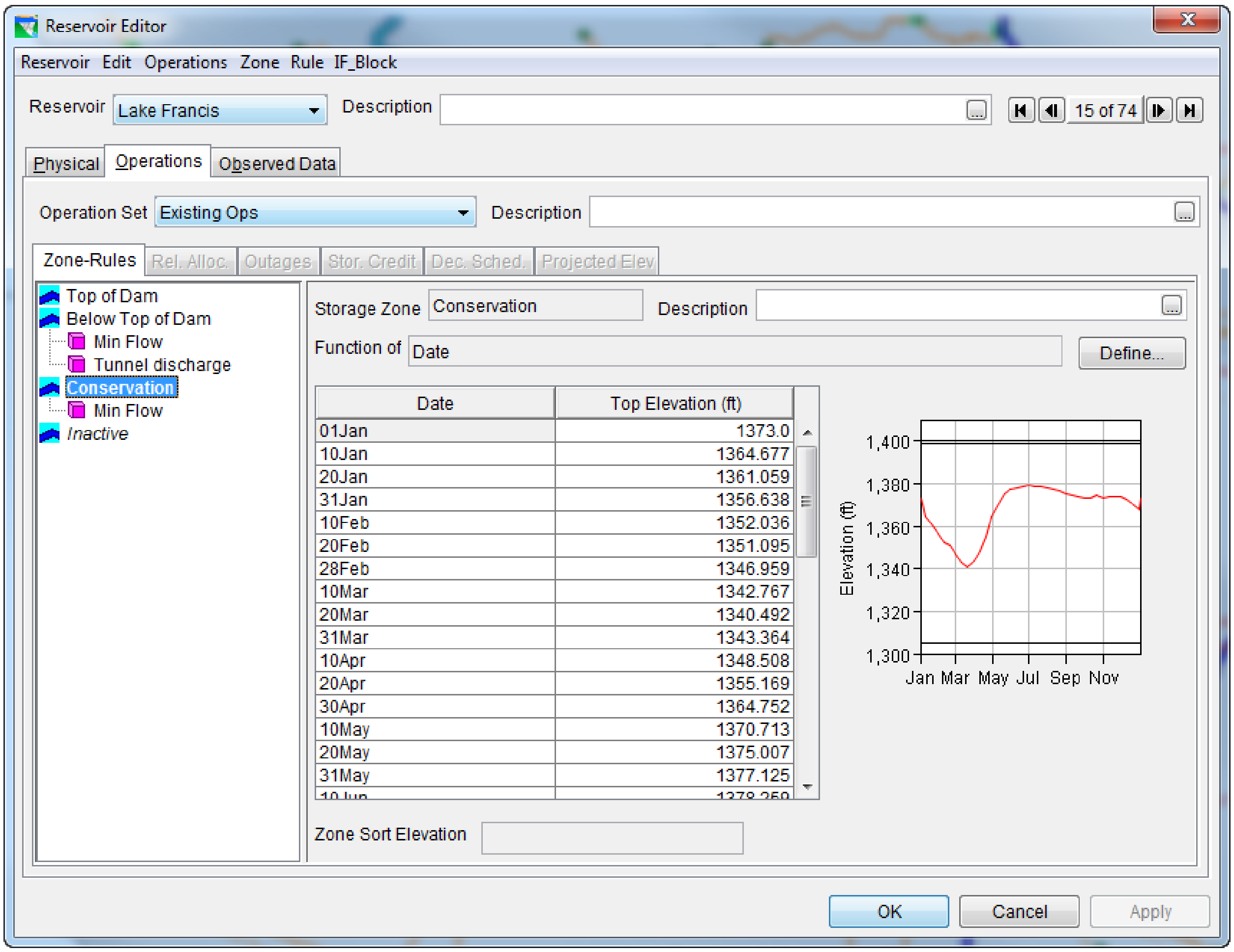


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing[51].

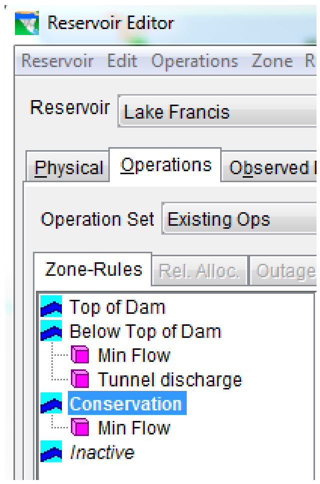


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Min Flow

Figure 7 shows the content of "Min Flow" rule. This rule represents the minimum release from dam as a function of date.

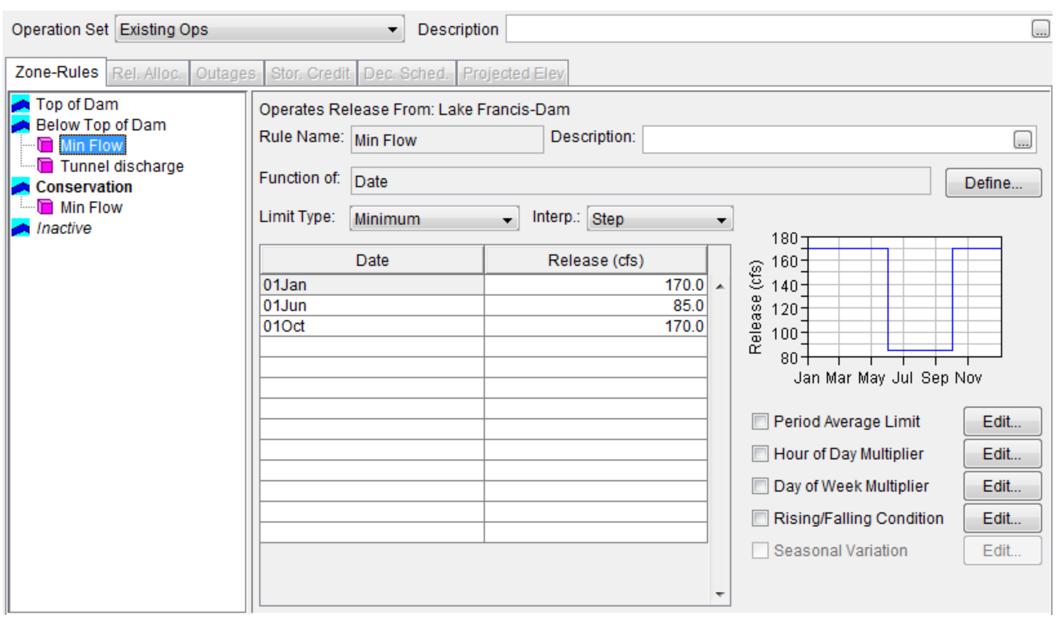


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow

[51] TransCanada. Connecticut River Operational Constraints. 2012.

2. Tunnel discharge

Figure 8 shows the content of "Tunnel discharge" rule. This rule represents the maximum release from the Tunnel discharge gate as a function of pool elevation.

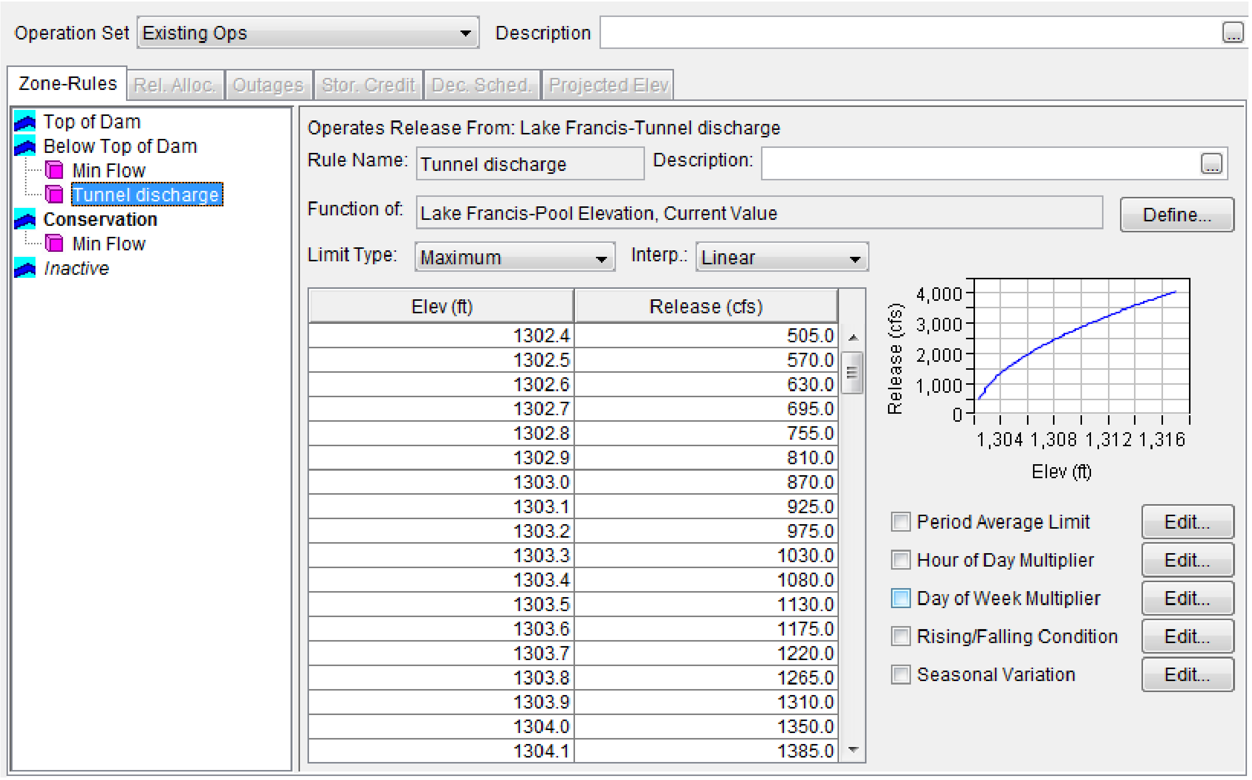


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Tunnel discharge

Lake Groton

I. Overview

Lake Groton dam is a dam located in Groton, VT at the headwaters of the Wells River. It is owned and operated by the State of Vermont Department of Water Resources and is used primarily for recreational purposes.

Figure 1 shows the location of Lake Groton Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo of Lake Groton Dam.

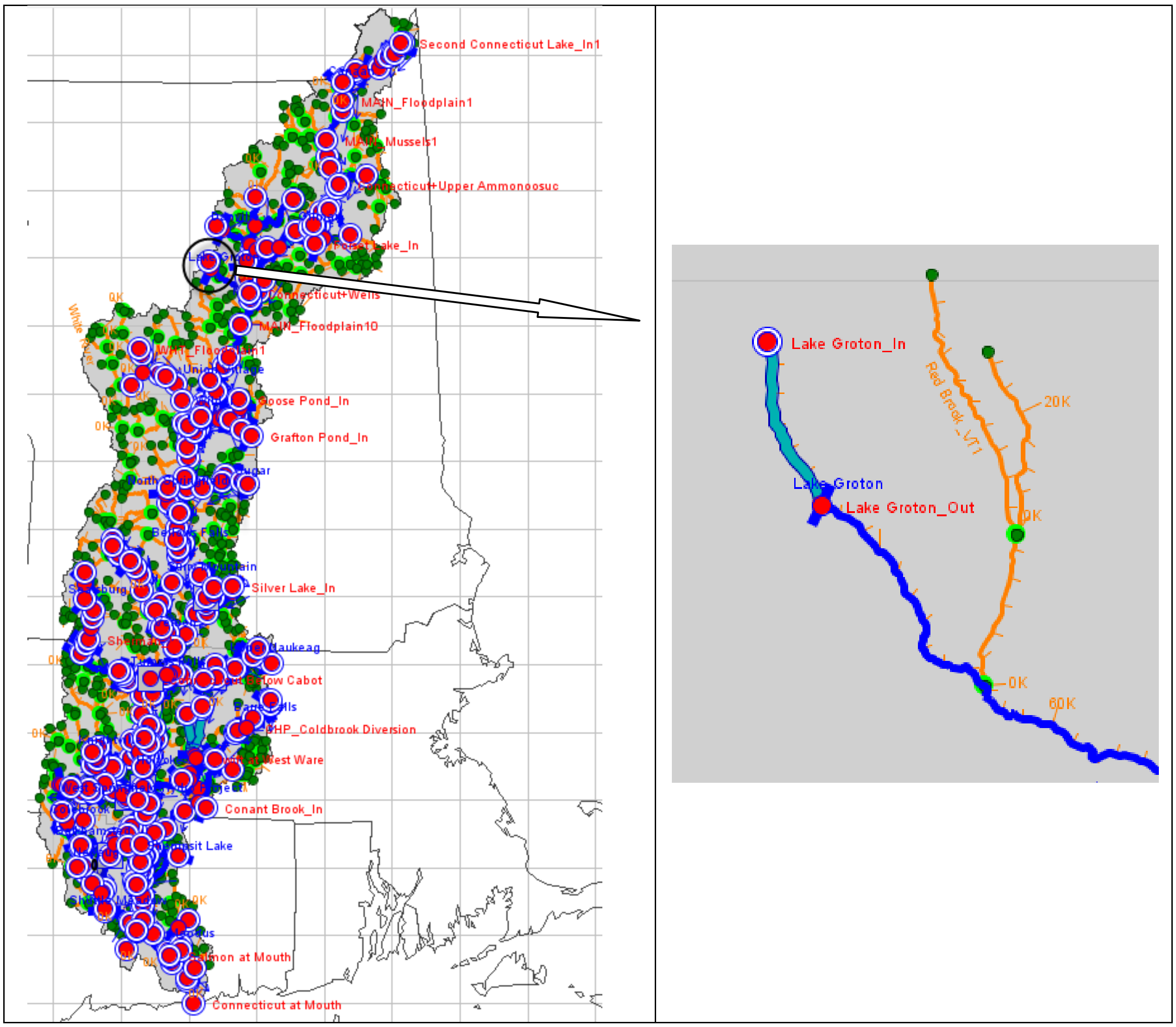


Figure 1: HEC-ResSim Map Display Showing Location of Somerset

Figure 2: Photo of Lake Groton Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[52]. The dam consists of four types of outlets: (1) uncontrolled spillway, (2) uncontrolled stop log spillway, (3) uncontrolled Core wall+ Embankment, and (4) uncontrolled Island as shown in Figure 4.

[52] State of Vermont Dam Inventory. 2010.

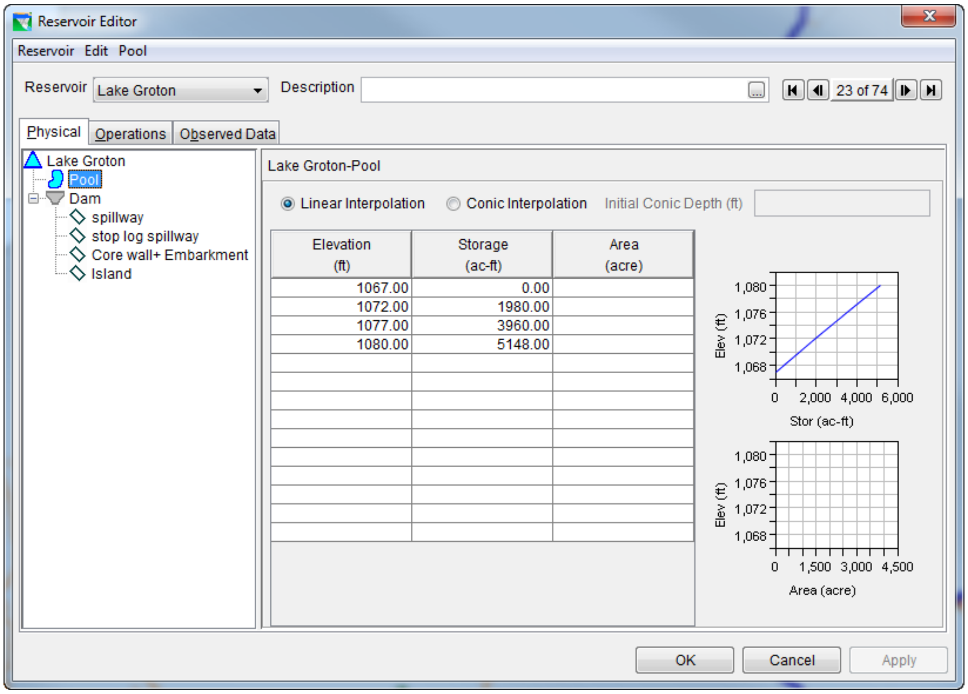


Figure 3: Reservoir Editor: Physical Tab -- Pool

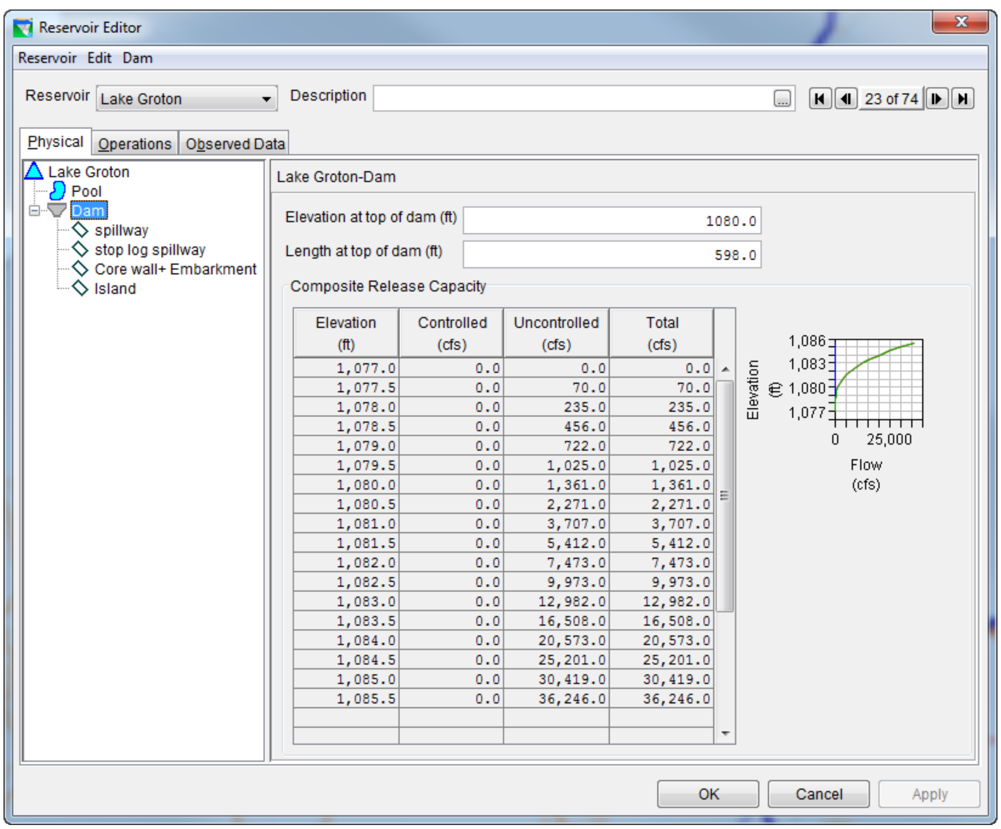


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Lake Groton's "Guide Curve" operational zones, which consist of zones of Top of dam (1080 ft), conservation (1077 ft), Min Pool (1076-1077 ft), and Inactive zone (1070 ft)[1].

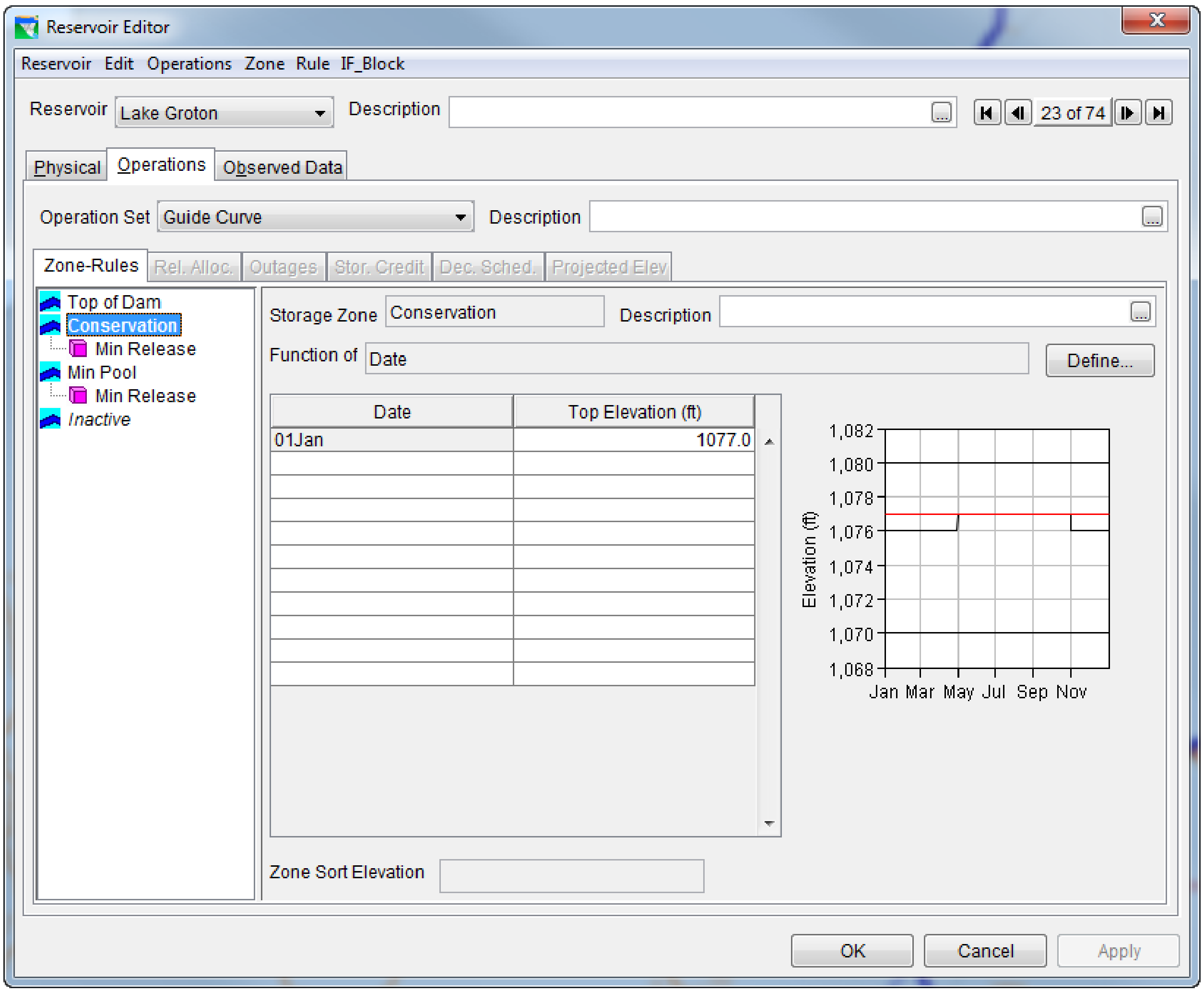


Figure 5: Reservoir Editor: Operations Tab –Guide Curve OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Guide Curve.

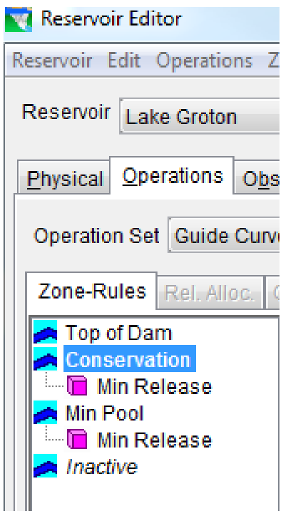


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Min release

Figure 7 shows the content of "Min release" rule. This rule represents a seasonal minimum flow as a function of Inflow.

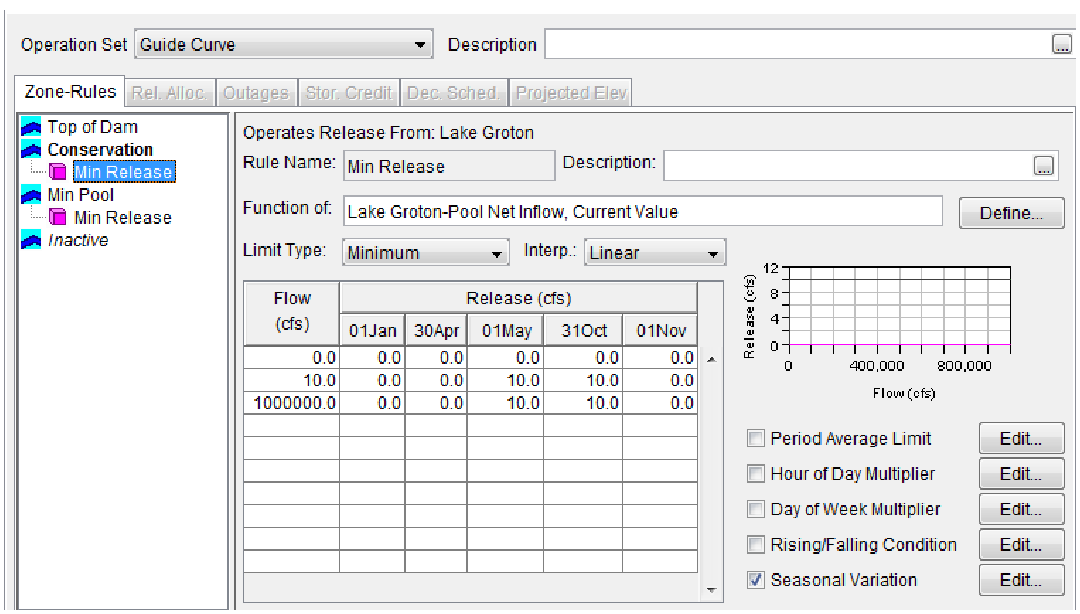


Figure 7: Reservoir Editor: Operations Tab – Guide Curve OpSet – Min Release

Lake McDonough

I. Overview

Lake McDonough dam is located directly downstream of Barkhamsted Reservoir that feeds into the Farmington River. It is owned and operated by The Metropolitan District of Hartford, Connecticut (MDC) and is used for recreation.

Figure 1 shows the location of Lake McDonough as it is represented in the HEC-ResSim model, and Figure 2 shows a photo for Lake McDonough.

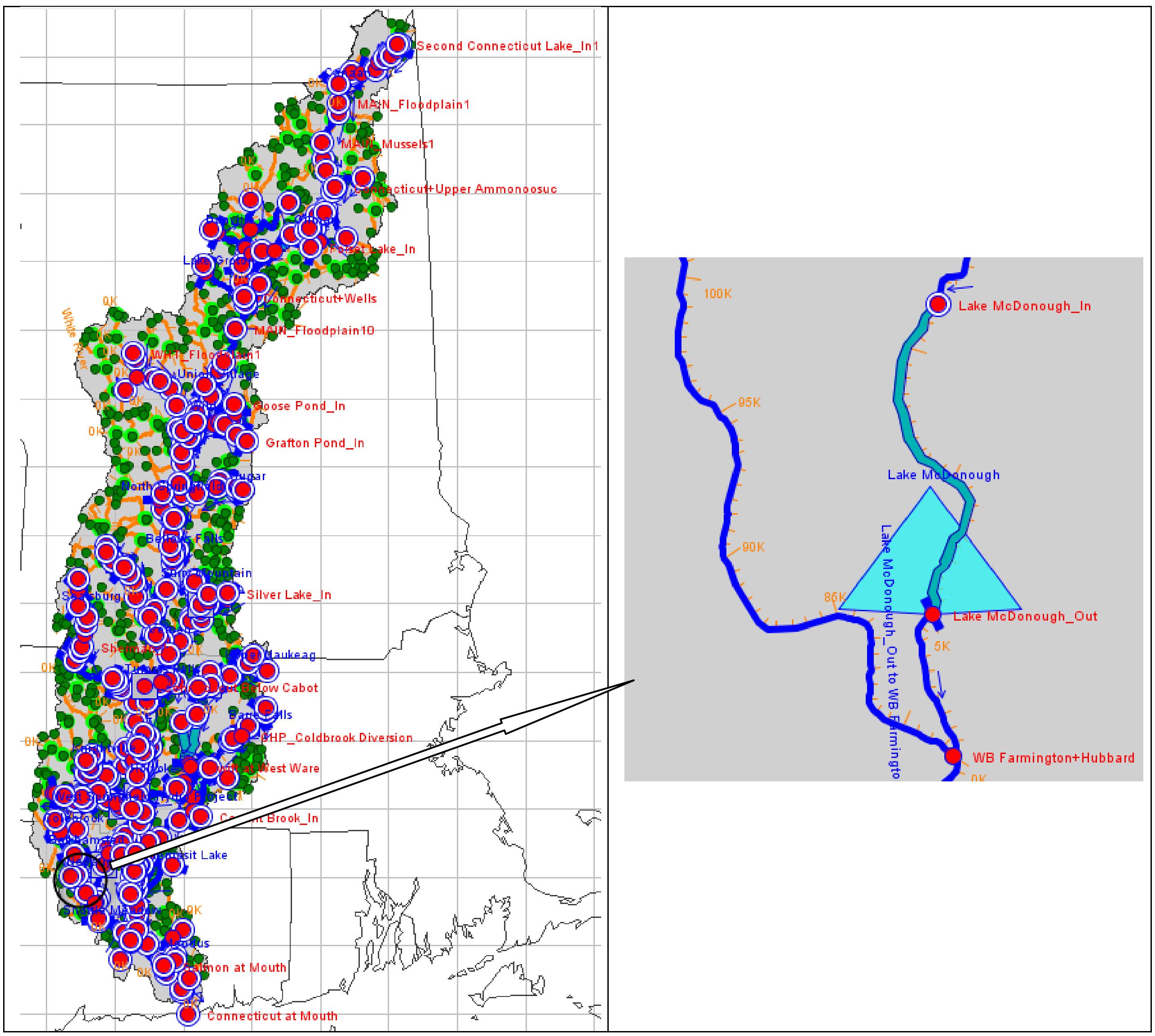


Figure 1: HEC-ResSim Map Display Showing Location of Lake McDonough

Figure 2: Aerial photo of Lake McDonough

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[53]. The dam consists of a controlled outlet as shown in Figure 4[54].

[53] MDC 1999
[54] Data from UMASS

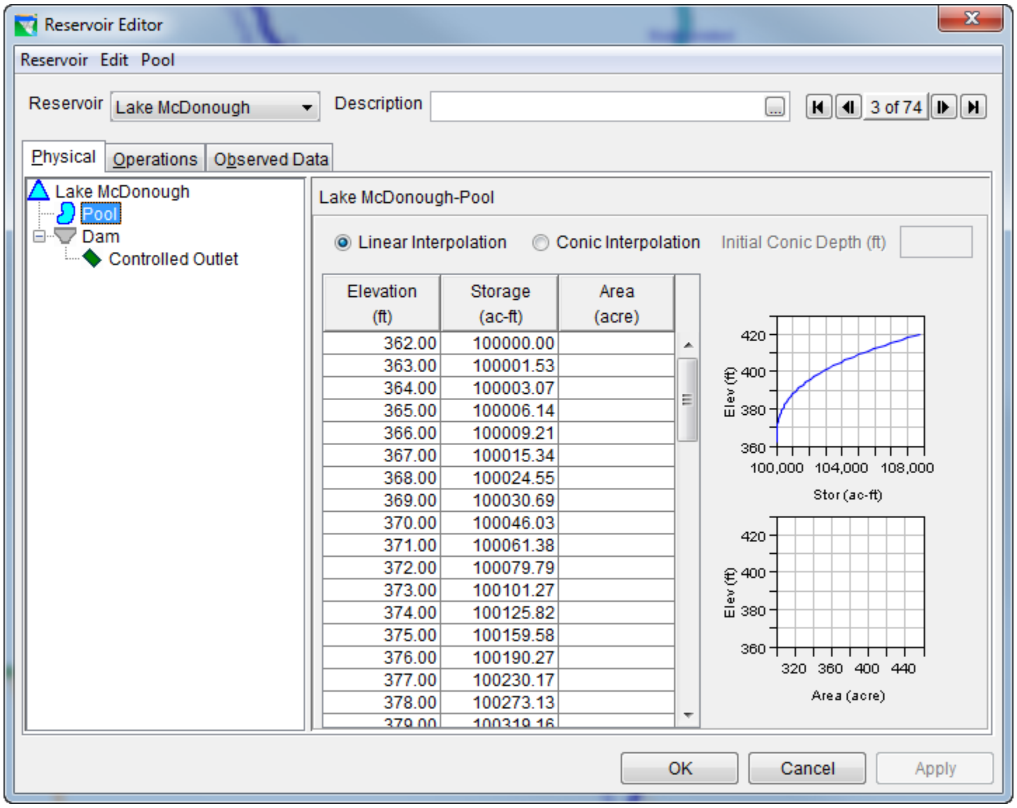


Figure 3: Reservoir Editor: Physical Tab -- Pool

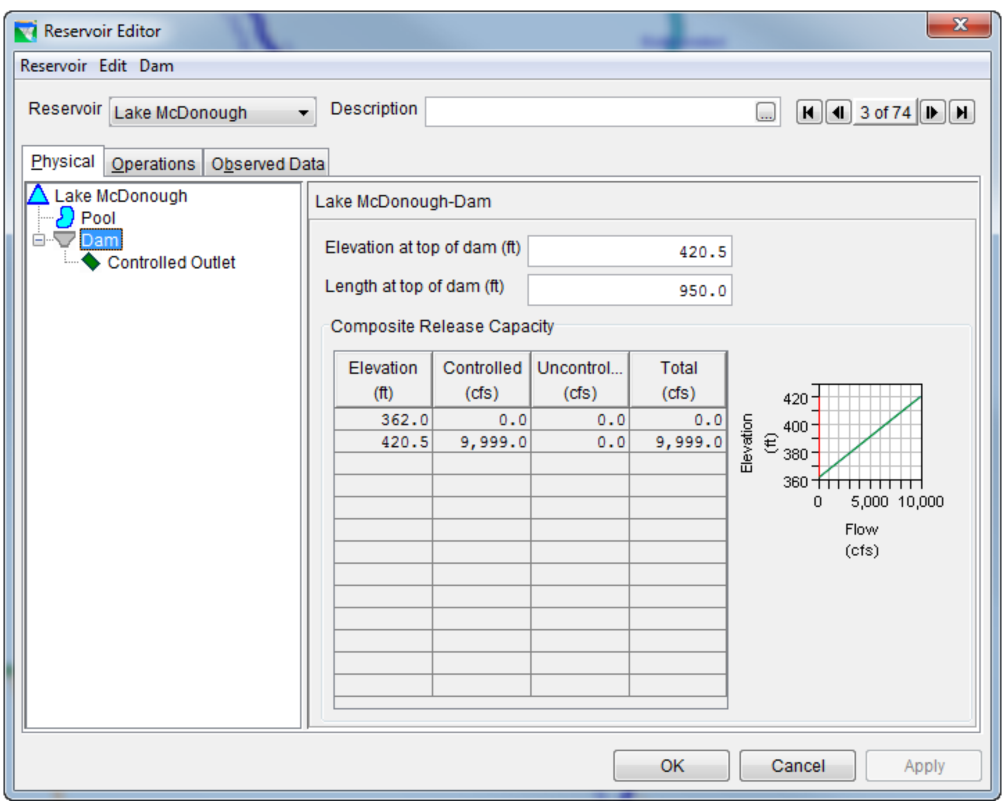


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Lake McDonough's "Existing Ops" operational zones, which consist of zones of Top of Dam (420.5 ft), Conservation (410-417.5 ft), and Inactive zone (362 ft)[2].

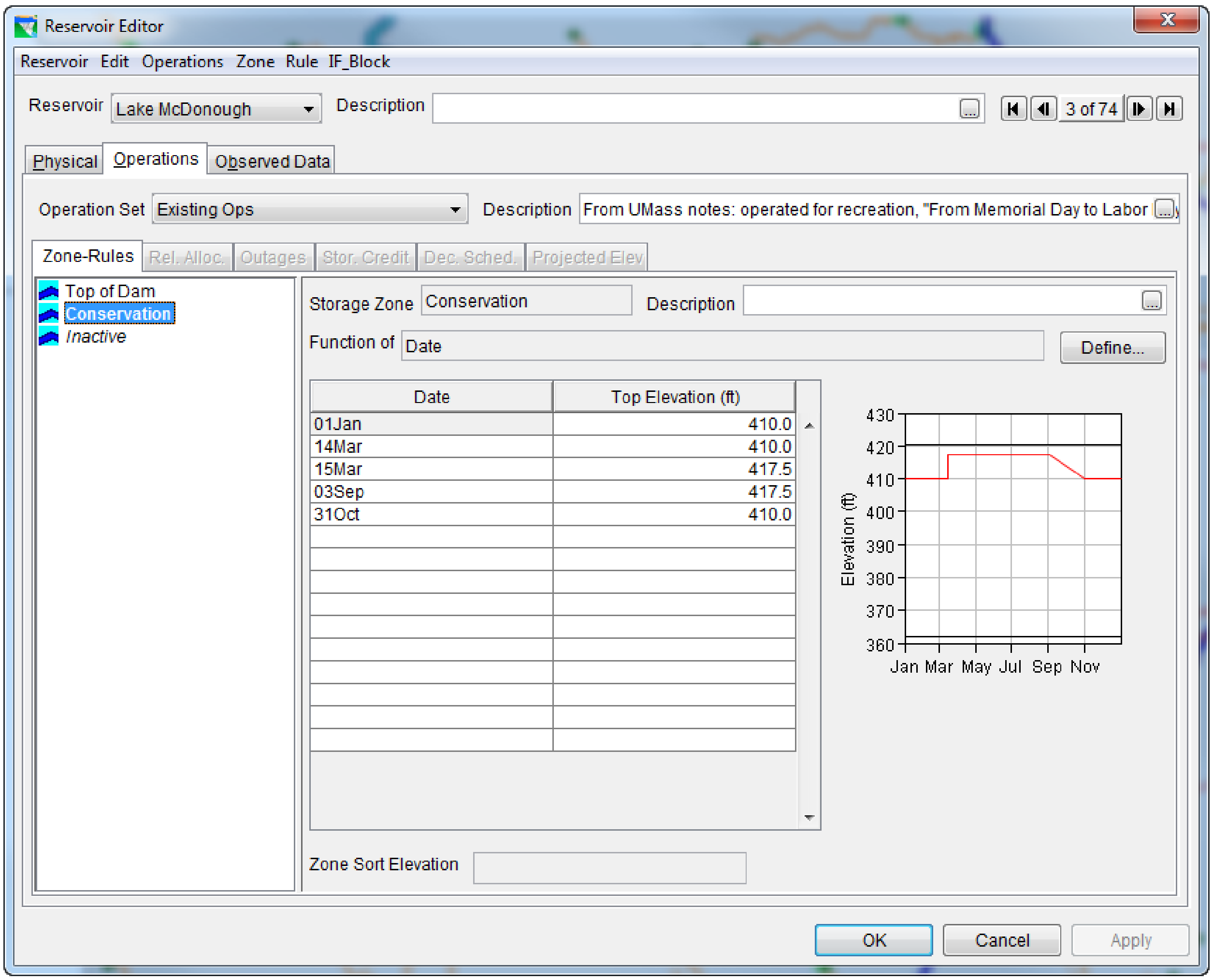


Figure 5: Reservoir Editor: Operations Tab – Existing Ops OpSet

B. Rule Illustrations

The operation set for Lake McDonough has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Lake Monomonac

I. Overview

Lake Monomonac dam is located in the town of Winchendon, MA on the Monomonac River that flows into the Millers River. The Town of Winchendon owns and operates the dam and is used primarily for recreational purposes.

Figure 1 shows the location of Upper Lake Monomonac Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Lake Monomonac.

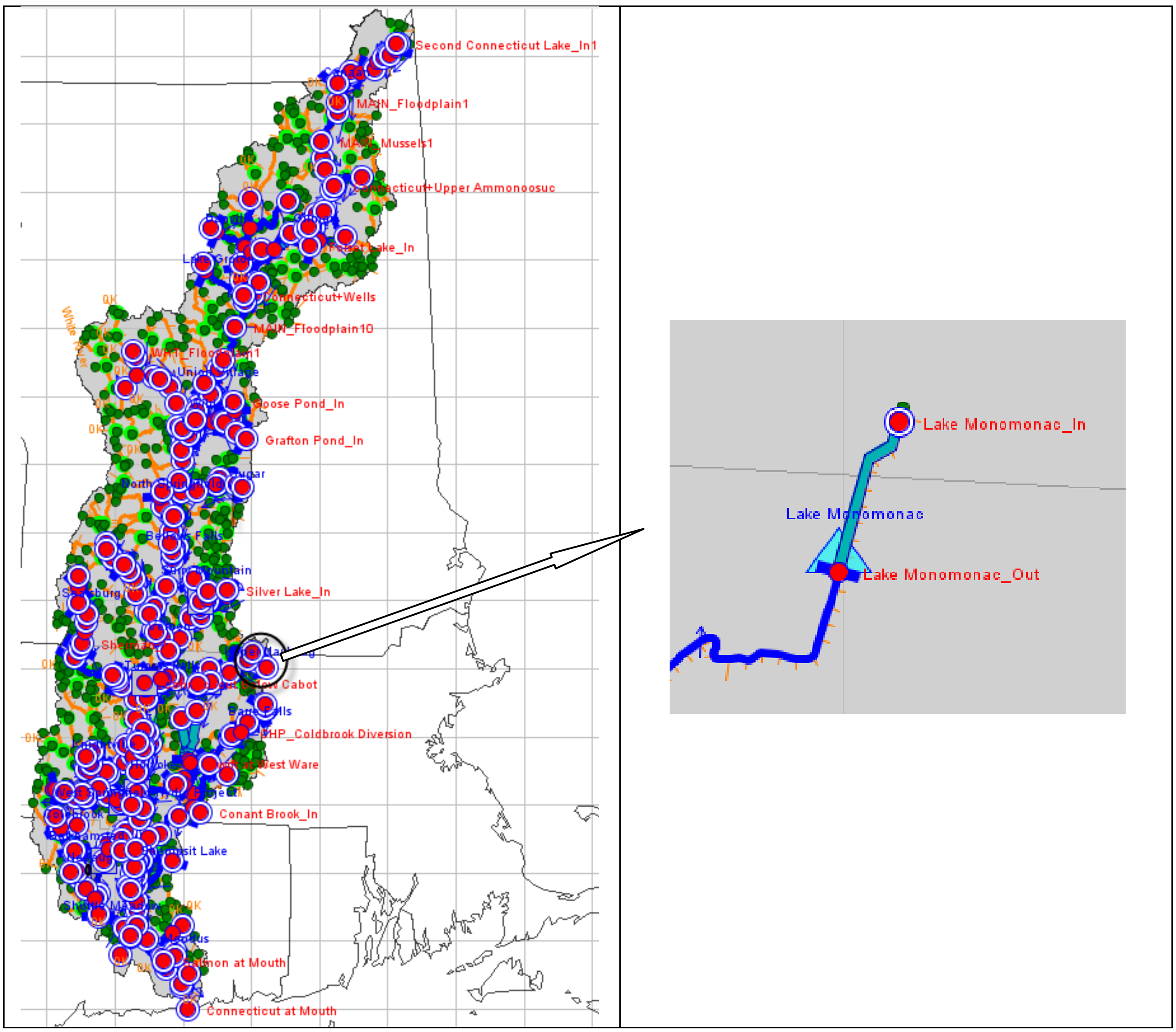


Figure 1: HEC-ResSim Map Display Showing Location of Lake Monomonac Dam

Figure 2: Photo of Lake Monomonac

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[55]. The dam consists of two types of outlets: (1) an uncontrolled outlet, and (2) a controlled outlet as shown in Figure 4.

[55] C.T. Male Associates, P.C. Lake Monomonac Dam.

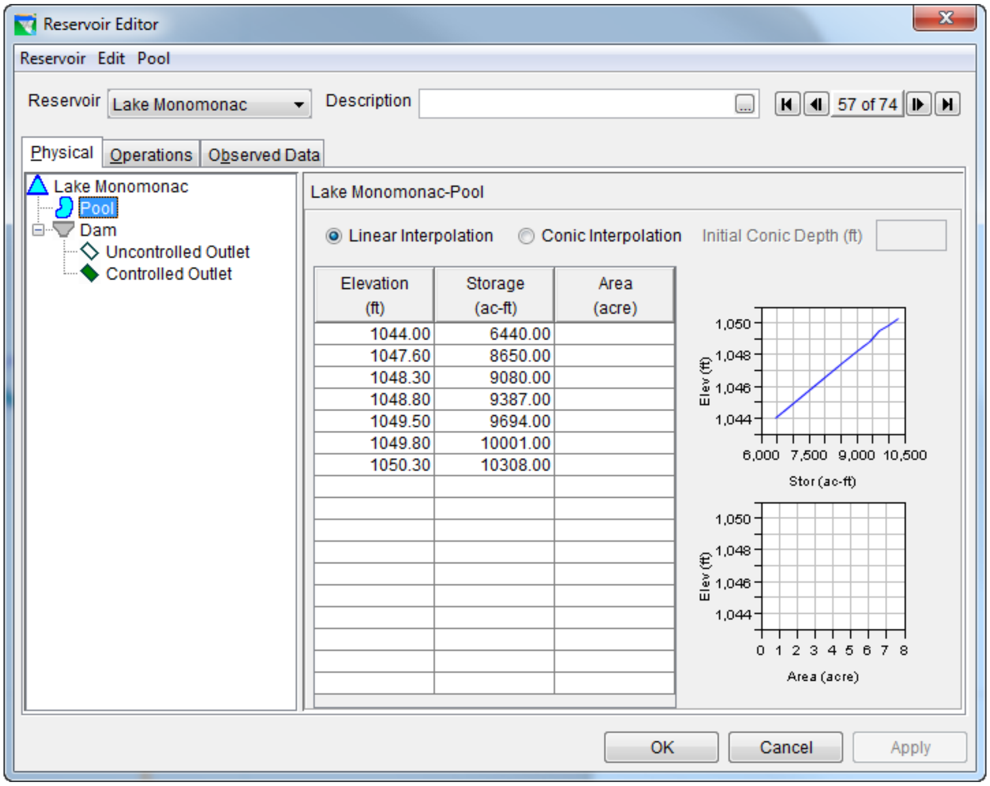


Figure 3: Reservoir Editor: Physical Tab -- Pool

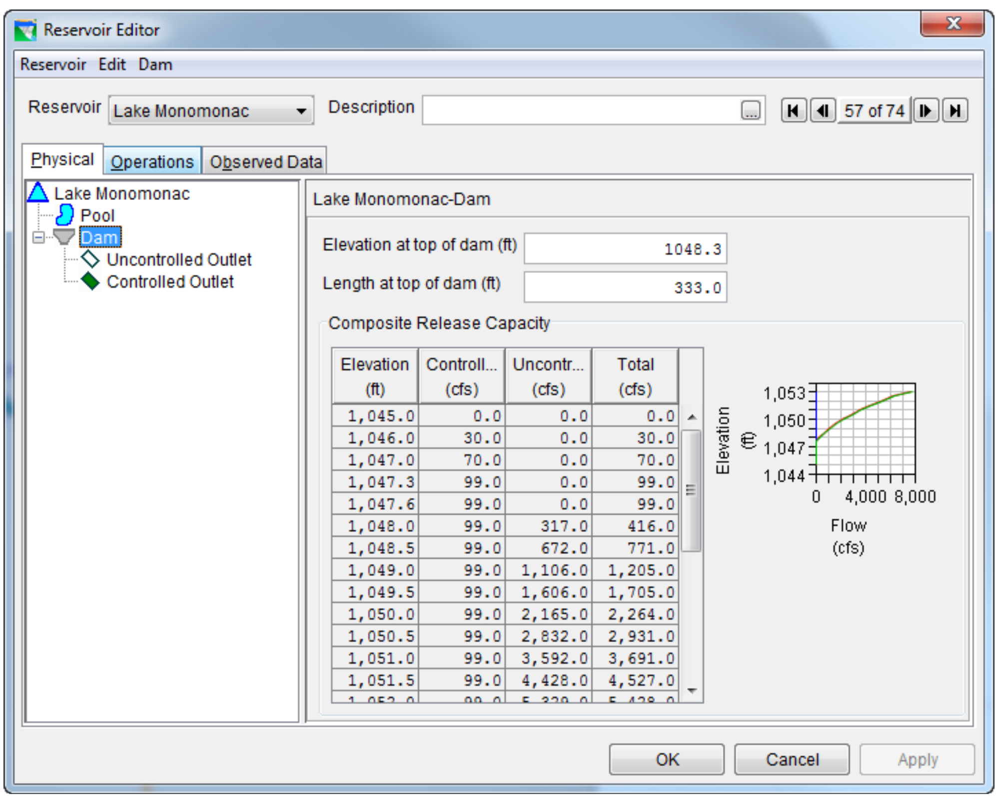


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Lake Monomonac Dam's "Guide Curve" operational zones, which consist of zones of Flood Control (1048.3 ft), Conservation (1045-1047 ft), and Inactive zone (1041 ft)[1].

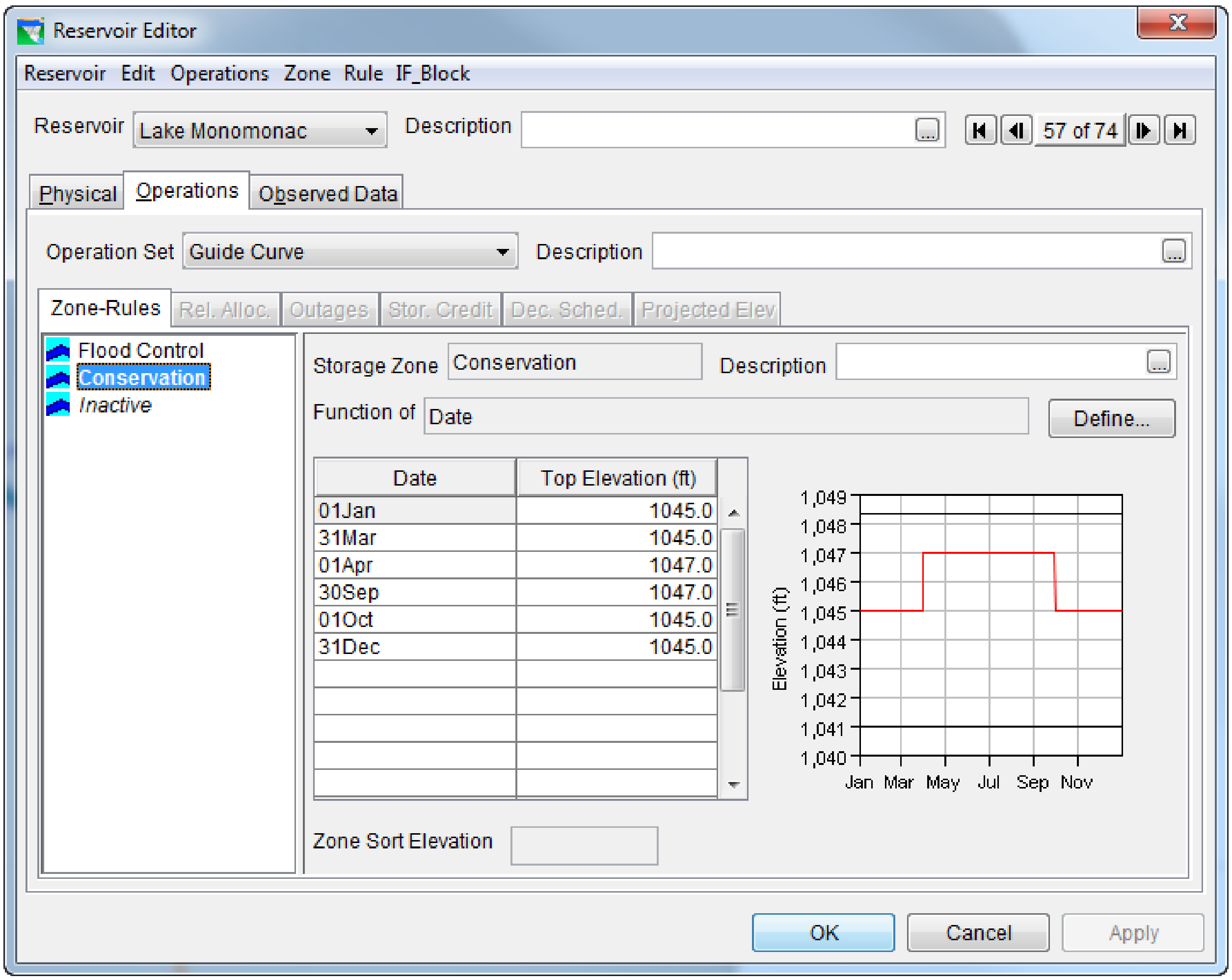


Figure 5: Reservoir Editor: Operations Tab – Guide Curve OpSet

B. Rule Illustrations

The operation set for Lake Monomonac Dam has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Lake Sunapee

I. Overview

Lake Sunapee dam is located in the town of Sunapee, NH on the Sugar River. It is owned and operated by the Town of Sunapee and is used for powering the town's water works pumping station as well as recreational purposes.

Figure 1 shows the location of Lake Sunapee Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Lake Sunapee.

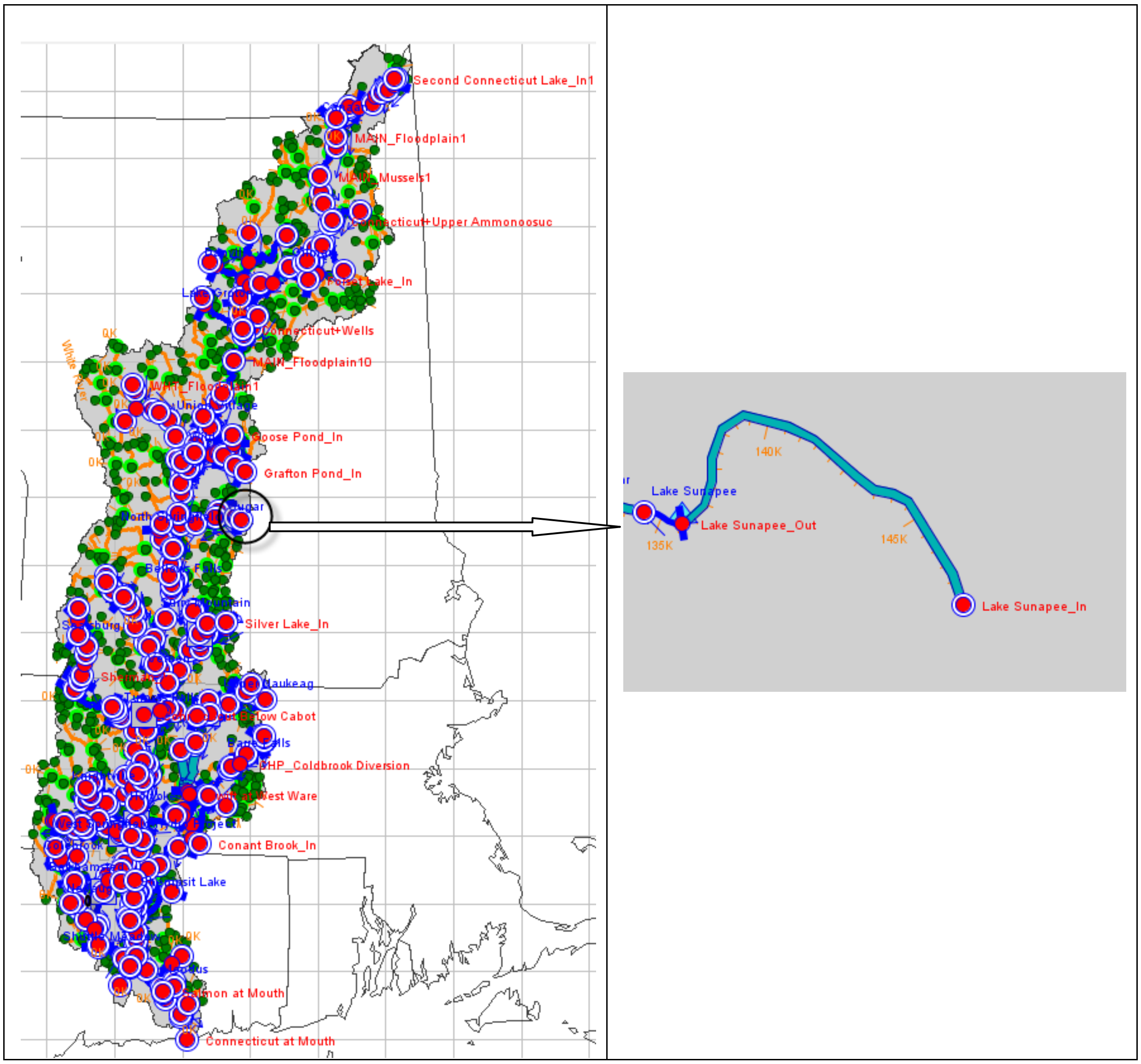


Figure 1: HEC-ResSim Map Display Showing Location of Lake Sunapee Dam

Figure 2: Photo of Lake Sunapee

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[56]. The dam consists of four types of outlets: (1) controlled Gates, (2) controlled sluice gate, (3) uncontrolled outlet, and (4) power plant as shown in Figure 4[57].

[56] NHDams Data Sheet. Lake Sunapee Dam. 2010

[57] Operations & Maintenance Plan. Lake Sunapee Dam. 2008.

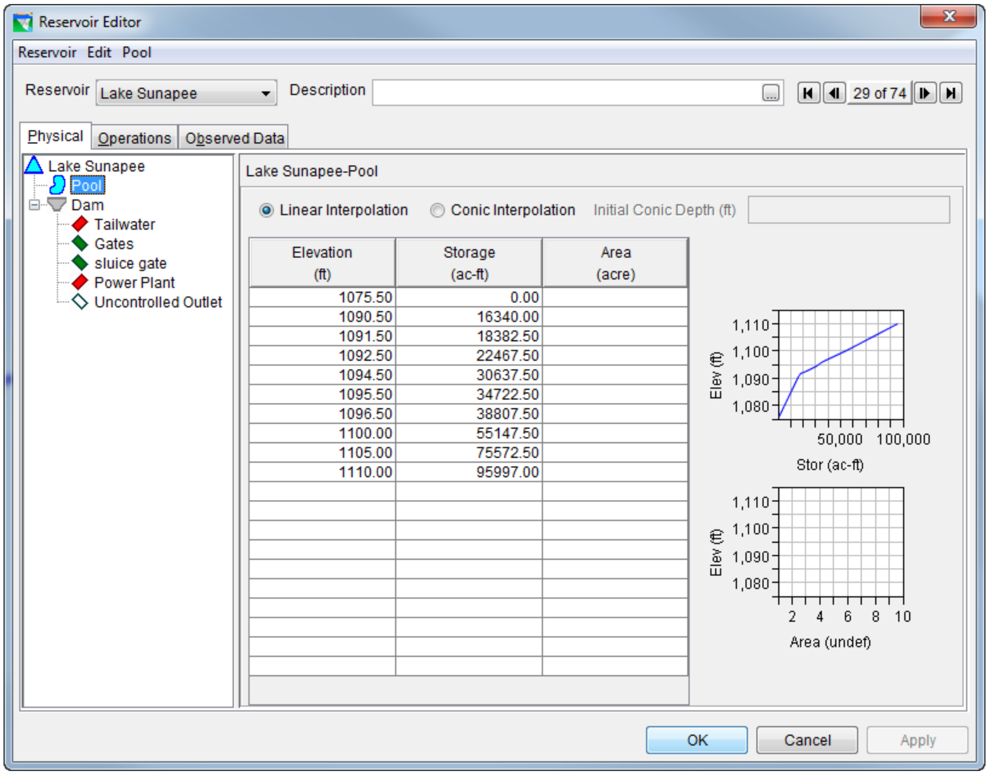


Figure 3: Reservoir Editor: Physical Tab -- Pool

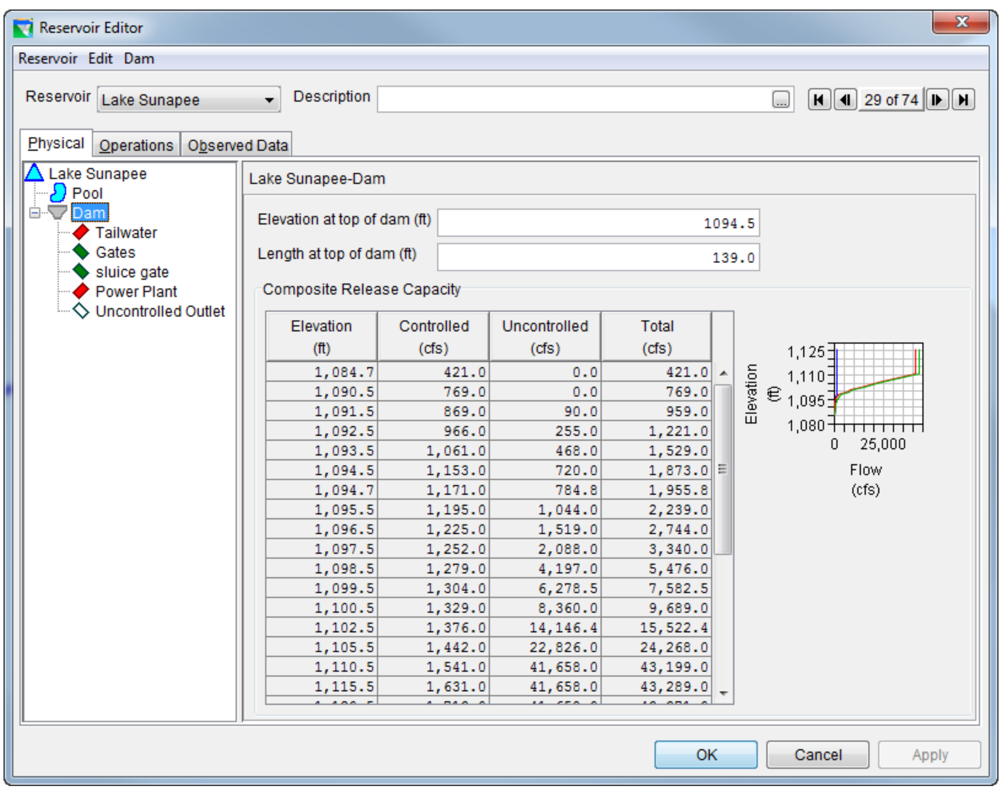


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Lake Sunapee's "Guide Curve" operational zones, which consist of zones of Maximum pool elevation (1099.2 ft), Top of Dam (1094.5 ft), Conservation (1090.5 ft), and Inactive zone (1075.5 ft)[2].

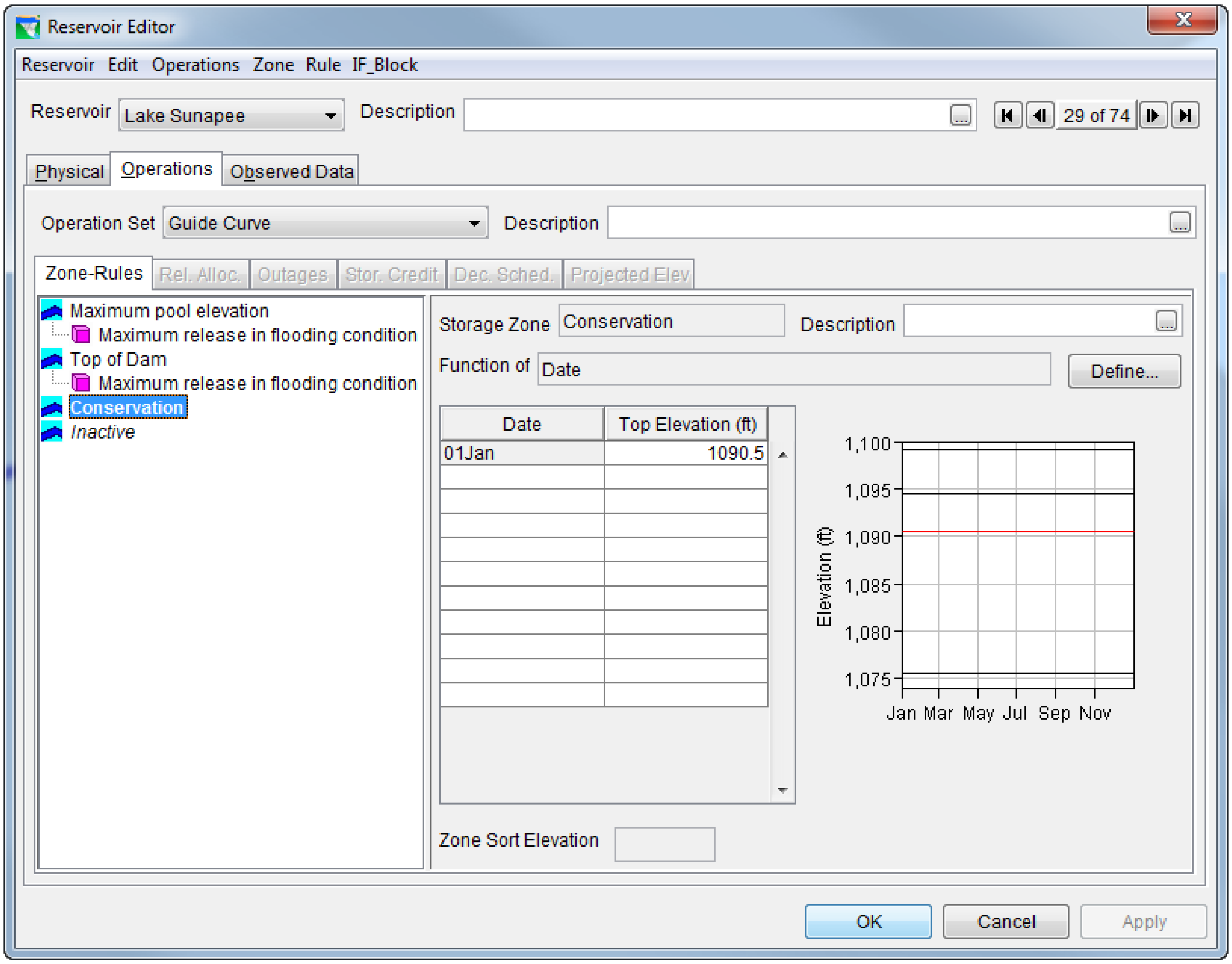


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Guide Curve.

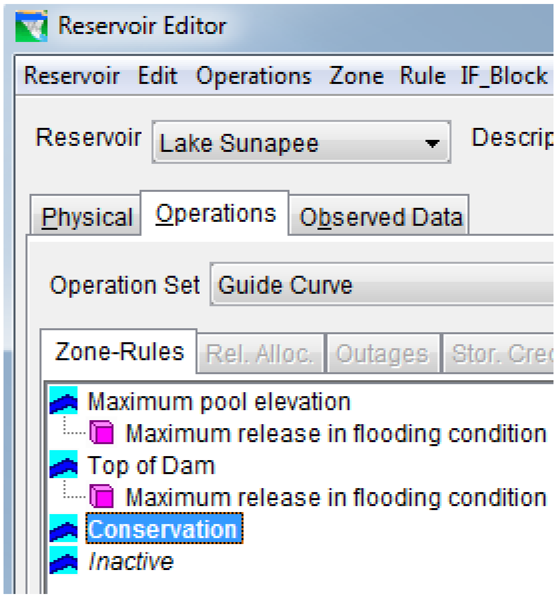


Figure 6: Reservoir Editor: Operations Tab – Guide Curve OpSet – Zones and Rules

C. Rule Descriptions

1. Maximum release in flooding condition

Figure 7 shows the content of "Maximum release in flooding condition" rule. This rule represents 750 cfs as a maximum release when the pool elevation is higher than conservation elevation.

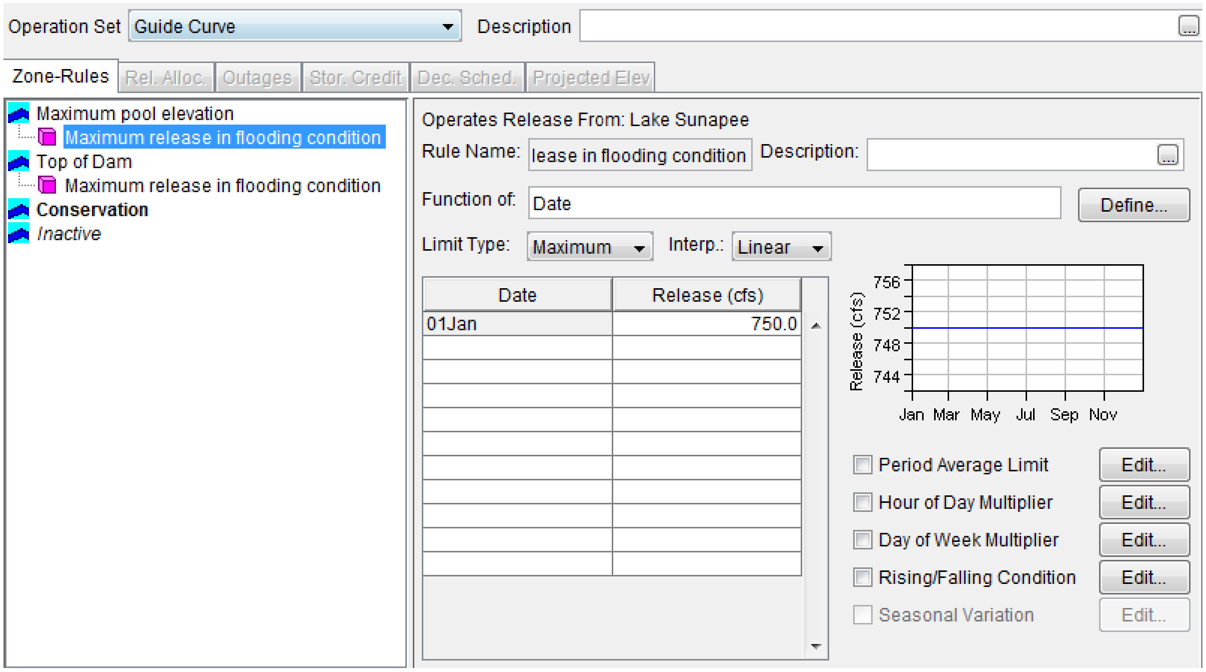


Figure 7: Reservoir Editor: Operations Tab – Guide Curve OpSet – Maximum release in flooding condition

Littleville

I. Overview

Littleville Dam is a dam on the Westfield River in Hampden County, Massachusetts. It was constructed in 1965 by the US Army Corps of Engineers and is still owned and operated by the Corps. It is primarily used for flood control purposes but is also used for recreation.

Figure 1 shows the location of Littleville Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the dam.

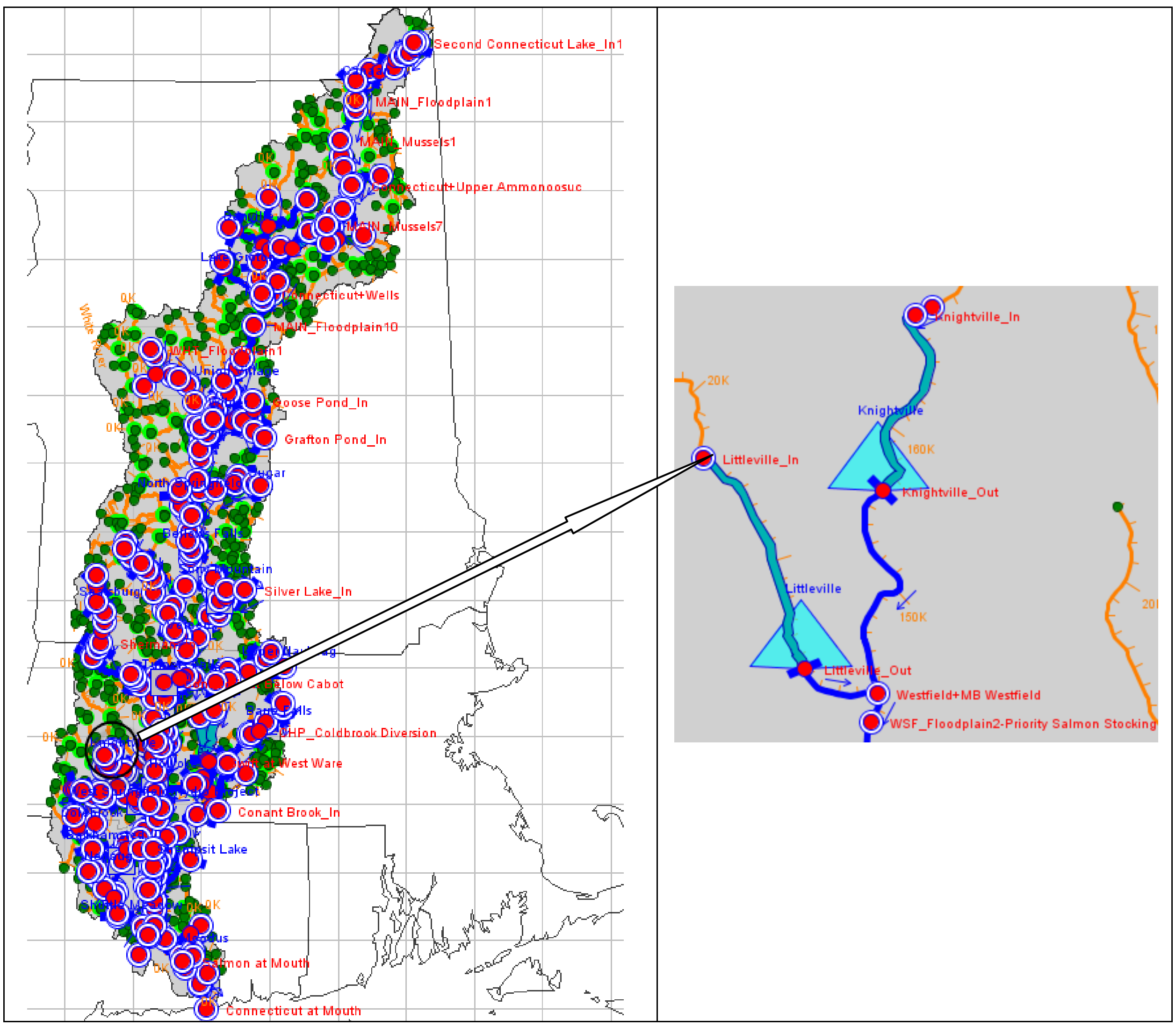


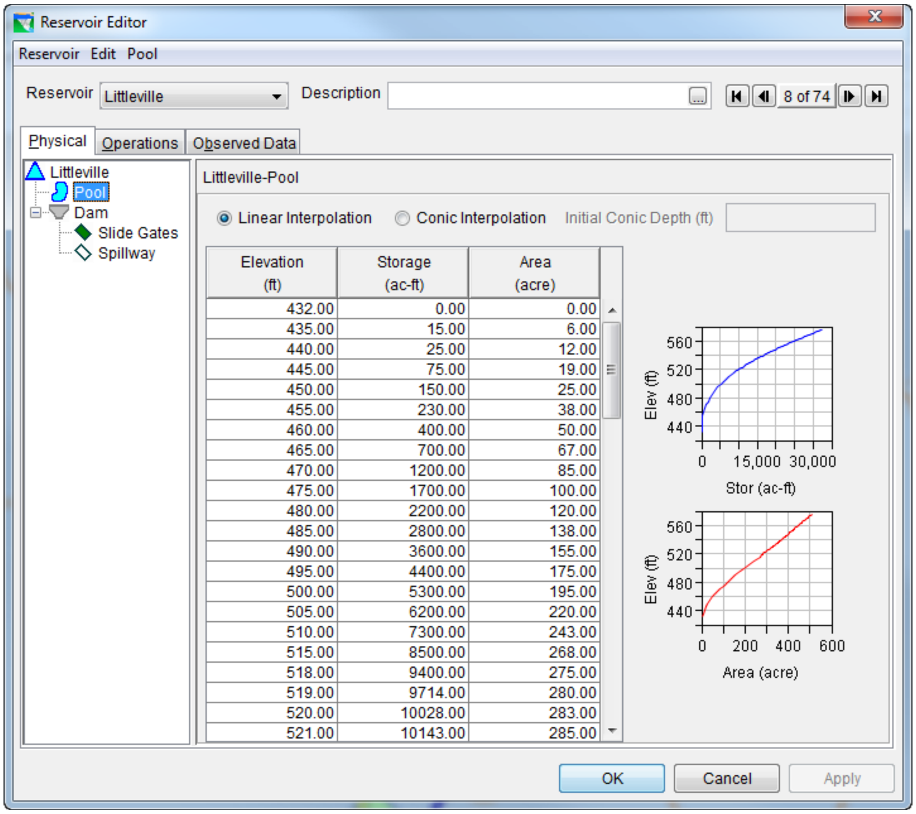
Figure 1: HEC-ResSim Map Display Showing Location of Littleville dam

Figure 2: Photo of Littleville Dam

II. Physical Characteristics

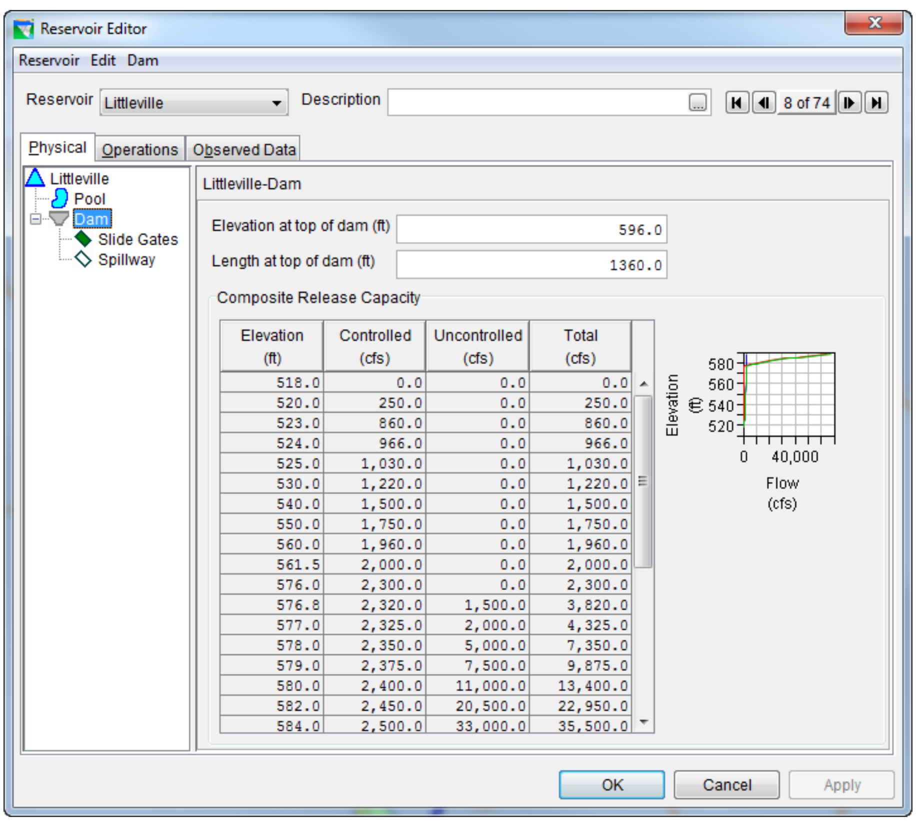
The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled slide gates, and (2) uncontrolled spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both personal correspondence and the Reservoir Regulation Team website[58].

[58] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index



Elevation (ft)	Storage (ac-ft)	Area (acre)
432.00	0.00	0.00
435.00	15.00	6.00
440.00	25.00	12.00
445.00	75.00	19.00
450.00	150.00	25.00
455.00	230.00	38.00
460.00	400.00	50.00
465.00	700.00	67.00
470.00	1200.00	85.00
475.00	1700.00	100.00
480.00	2200.00	120.00
485.00	2800.00	138.00
490.00	3600.00	155.00
495.00	4400.00	175.00
500.00	5300.00	195.00
505.00	6200.00	220.00
510.00	7300.00	243.00
515.00	8500.00	268.00
518.00	9400.00	275.00
519.00	9714.00	280.00
520.00	10028.00	283.00
521.00	10143.00	285.00

Figure 3: Reservoir Editor: Physical Tab -- Pool



Elevation (ft)	Controlled (cfs)	Uncontrolled (cfs)	Total (cfs)
518.0	0.0	0.0	0.0
520.0	250.0	0.0	250.0
523.0	860.0	0.0	860.0
524.0	966.0	0.0	966.0
525.0	1,030.0	0.0	1,030.0
530.0	1,220.0	0.0	1,220.0
540.0	1,500.0	0.0	1,500.0
550.0	1,750.0	0.0	1,750.0
560.0	1,960.0	0.0	1,960.0
561.5	2,000.0	0.0	2,000.0
576.0	2,300.0	0.0	2,300.0
576.8	2,320.0	1,500.0	3,820.0
577.0	2,325.0	2,000.0	4,325.0
578.0	2,350.0	5,000.0	7,350.0
579.0	2,375.0	7,500.0	9,875.0
580.0	2,400.0	11,000.0	13,400.0
582.0	2,450.0	20,500.0	22,950.0
584.0	2,500.0	33,000.0	35,500.0

Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 4 shows the definition of Littleville's "ExistingOps" operational zones, which consist of zones of Surcharge (596 ft), Flood Control (576 ft), Conservation (518.5 ft), and Inactive zone (518 ft).

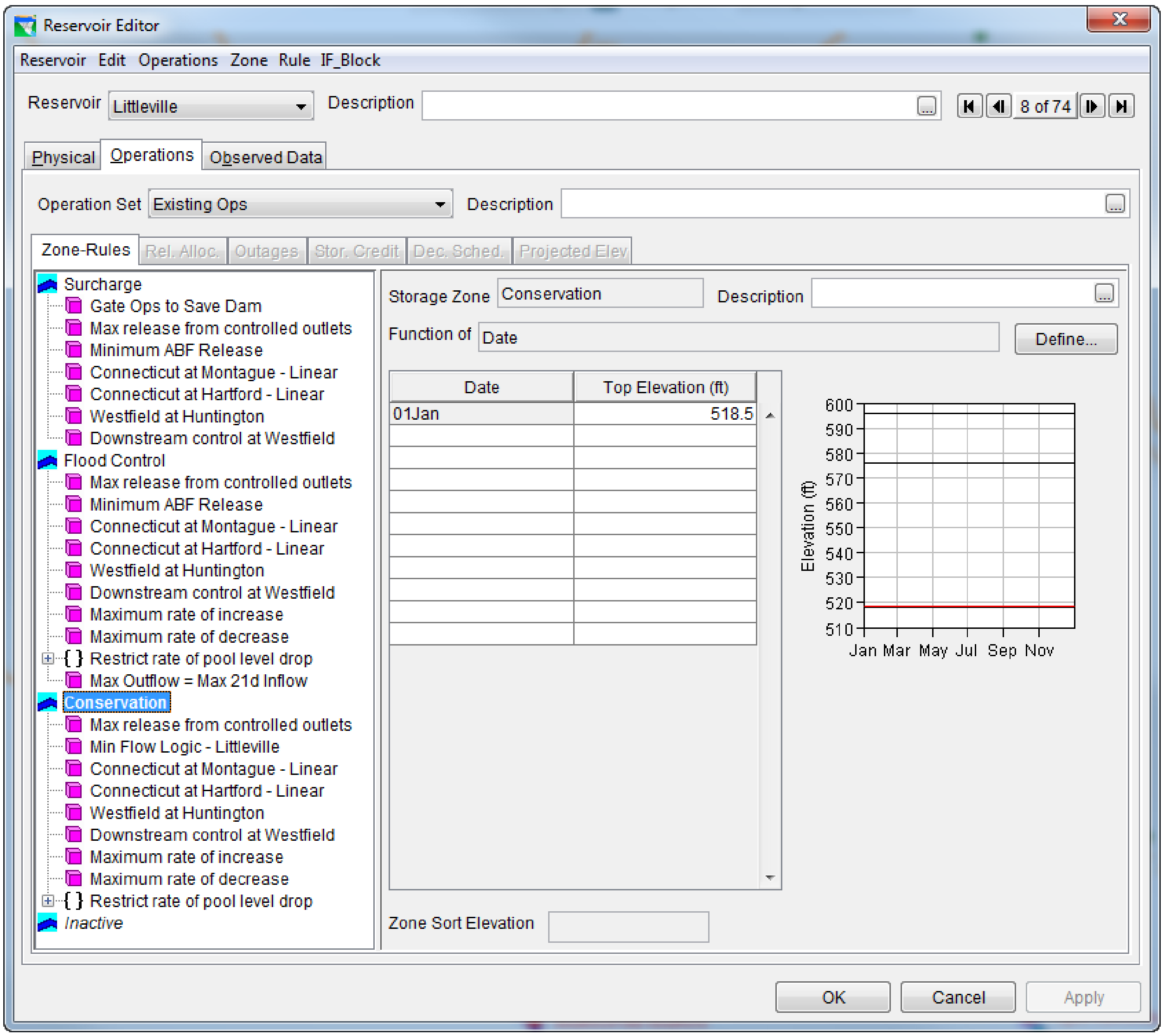


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

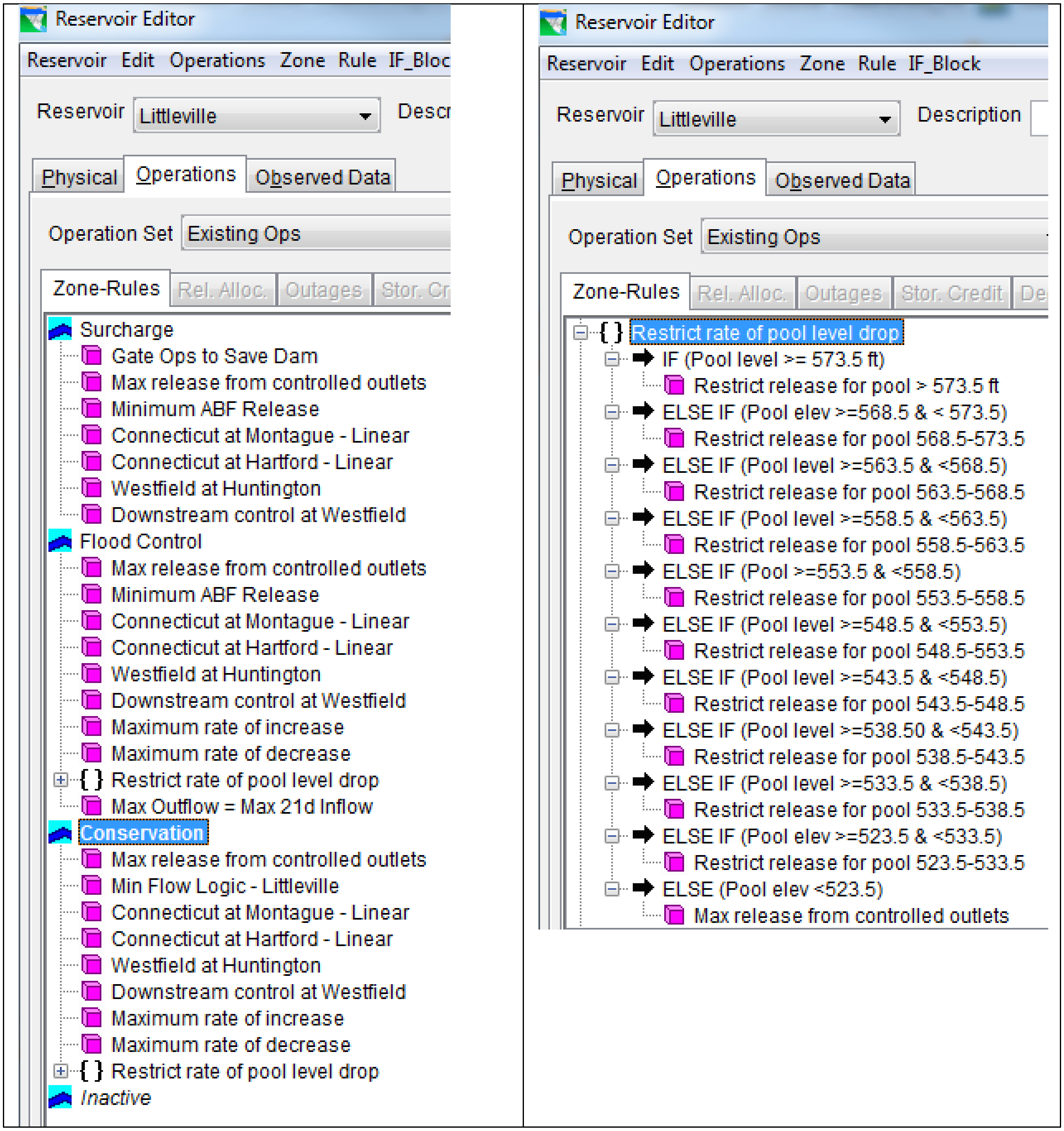


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Gate Ops to Save Dam

Figure 7 shows the content of “Gate Ops to Save Dam” rule. This rule represents the maximum allowable release from Slide gates as a function of pool elevation when the pool is in Surcharge zone.

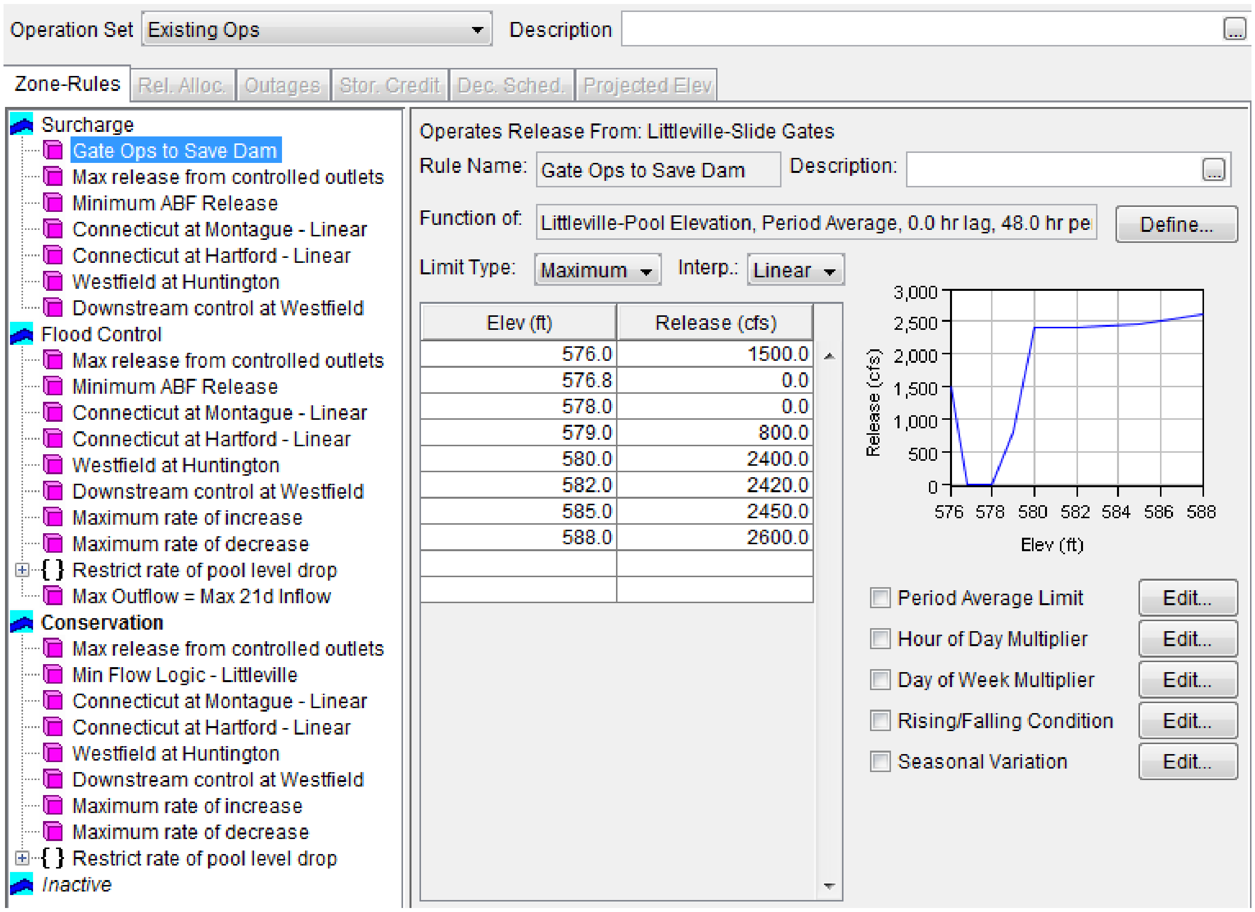


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet –Gate Ops to Save Dam

2. *Max release from controlled outlets*

Figure 8 shows the content of "Max release from controlled outlets" rule. This rule represents the maximum allowable release from Slide gates.

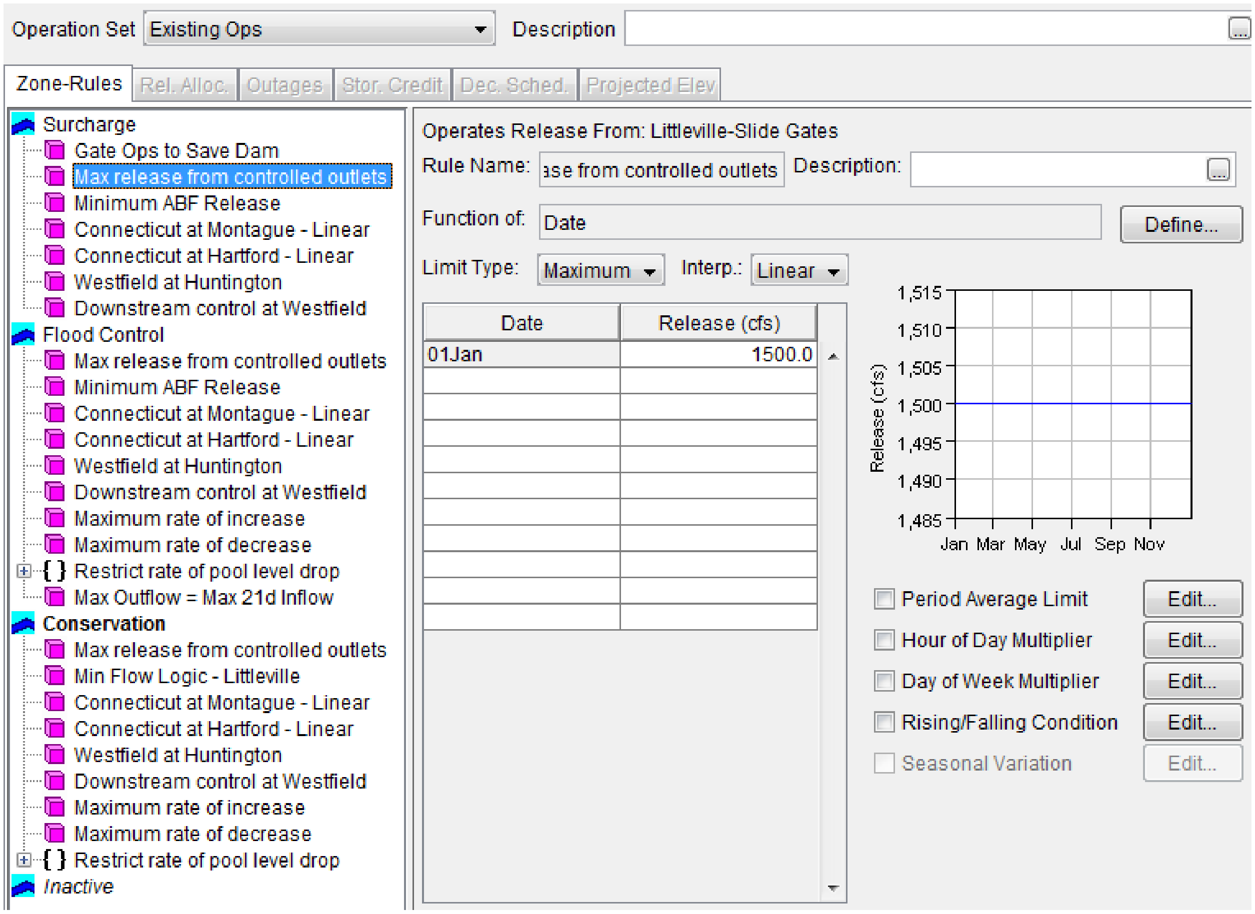


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max release from controlled outlets

3. *Minimum ABF Release*

Figure 9 shows the content of "Minimum ABF Release" rule. This rule represents the minimum required release from slide gates during flood control operations.

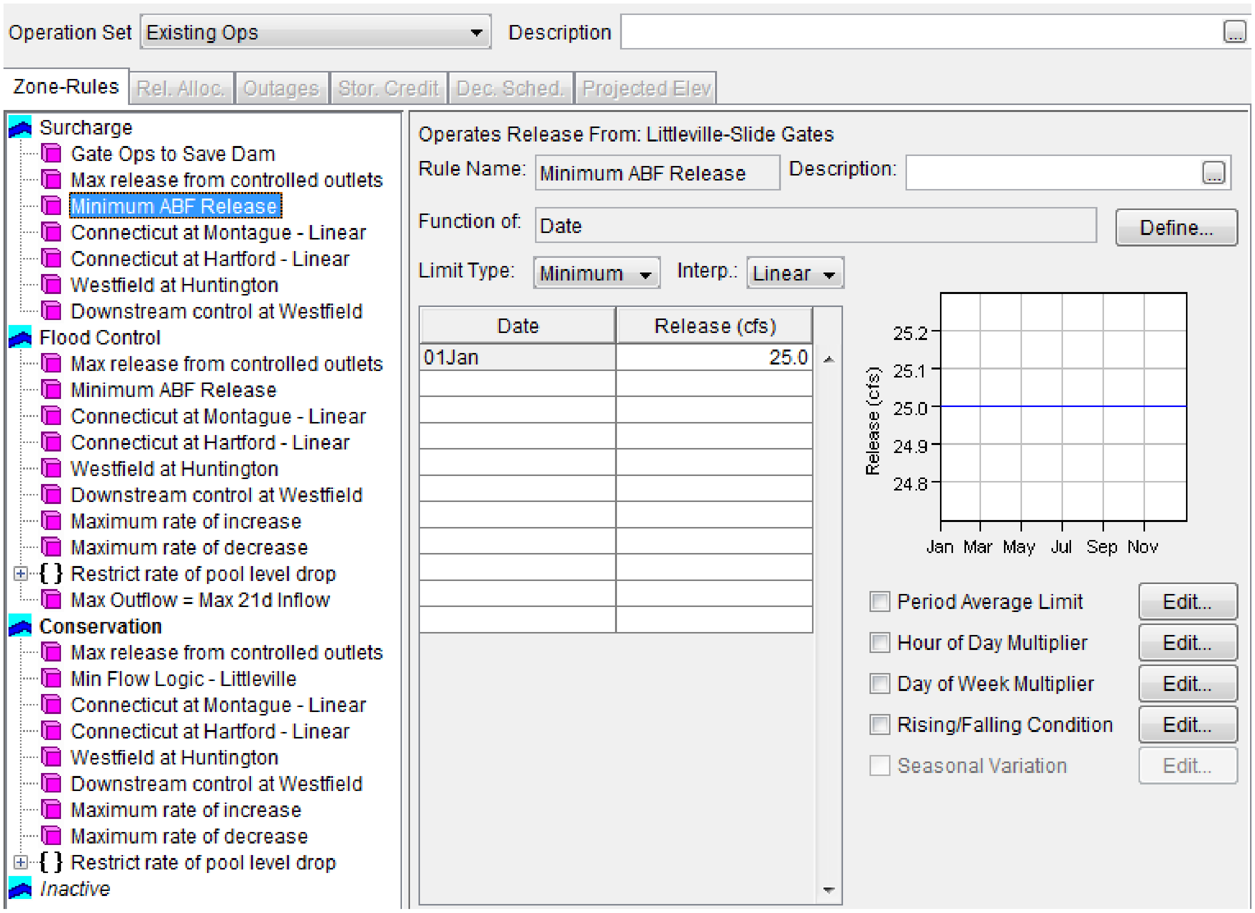


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet –Minimum ABF Release

4. Connectict at Montague-Linear

Figure 10 shows the content of "Connecticut at Montague-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montage. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

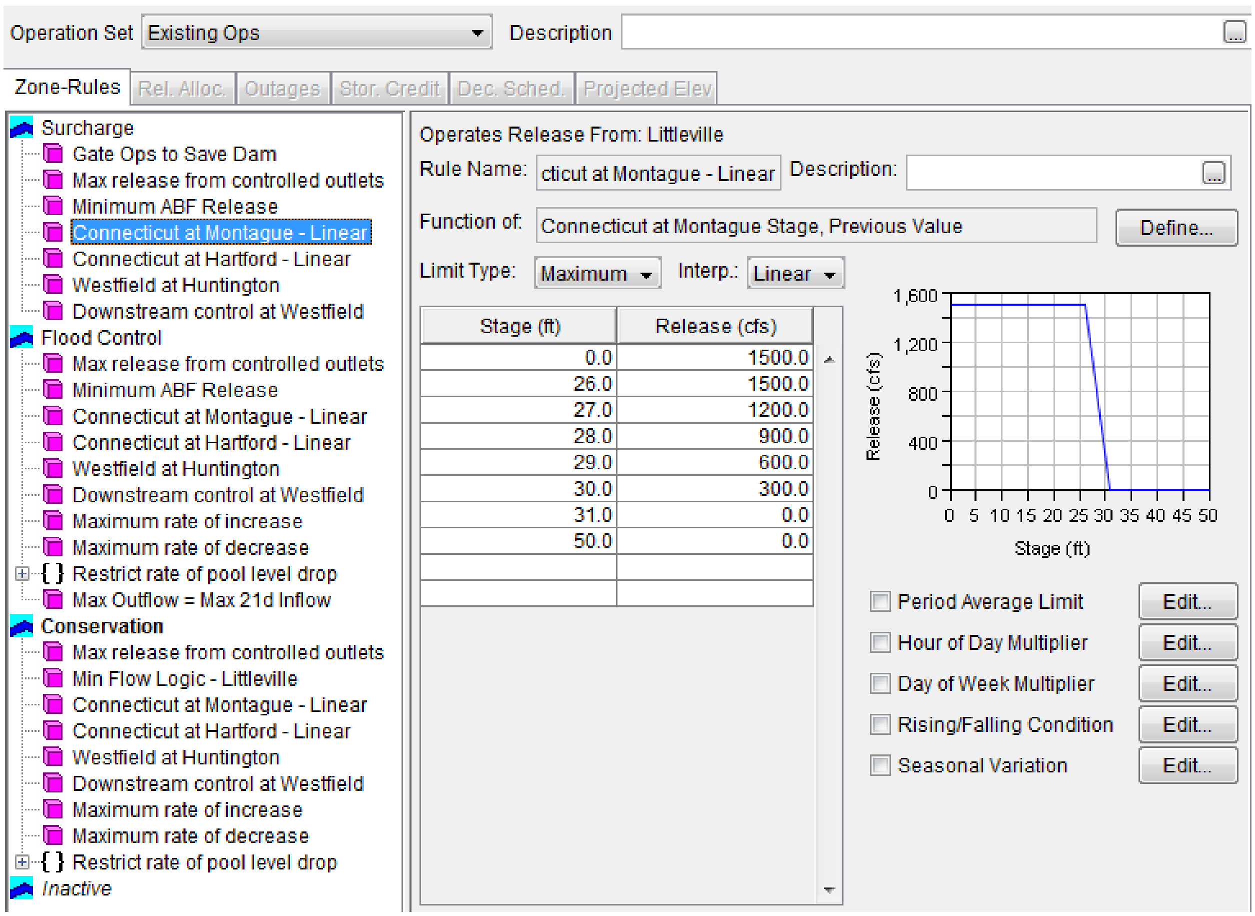


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet –Connecticut at Montague-Linear

5. *Connecticut at Hartford-Linear*

Figure 10 shows the content of "Connecticut at Hartford-Linear" rule. This rule represents the maximum allowable release from dam as a function of previous day stage at Hartford. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

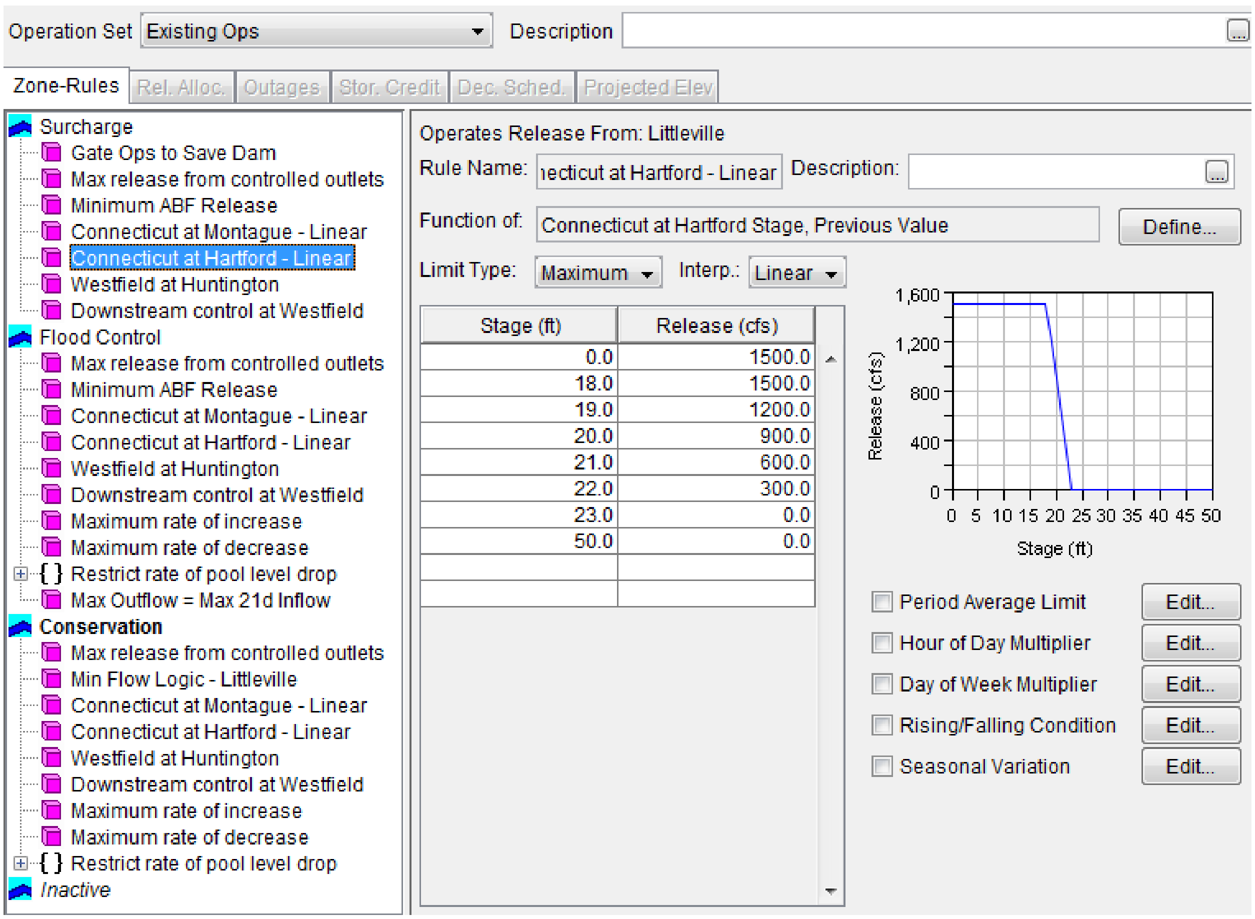


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Hartford-Linear

6. Westfield at Huntington

Figure 12 shows the content of "Westfield at Huntington" rule. This rule represents the maximum allowable release from dam as a function of previous day stage at Huntington. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

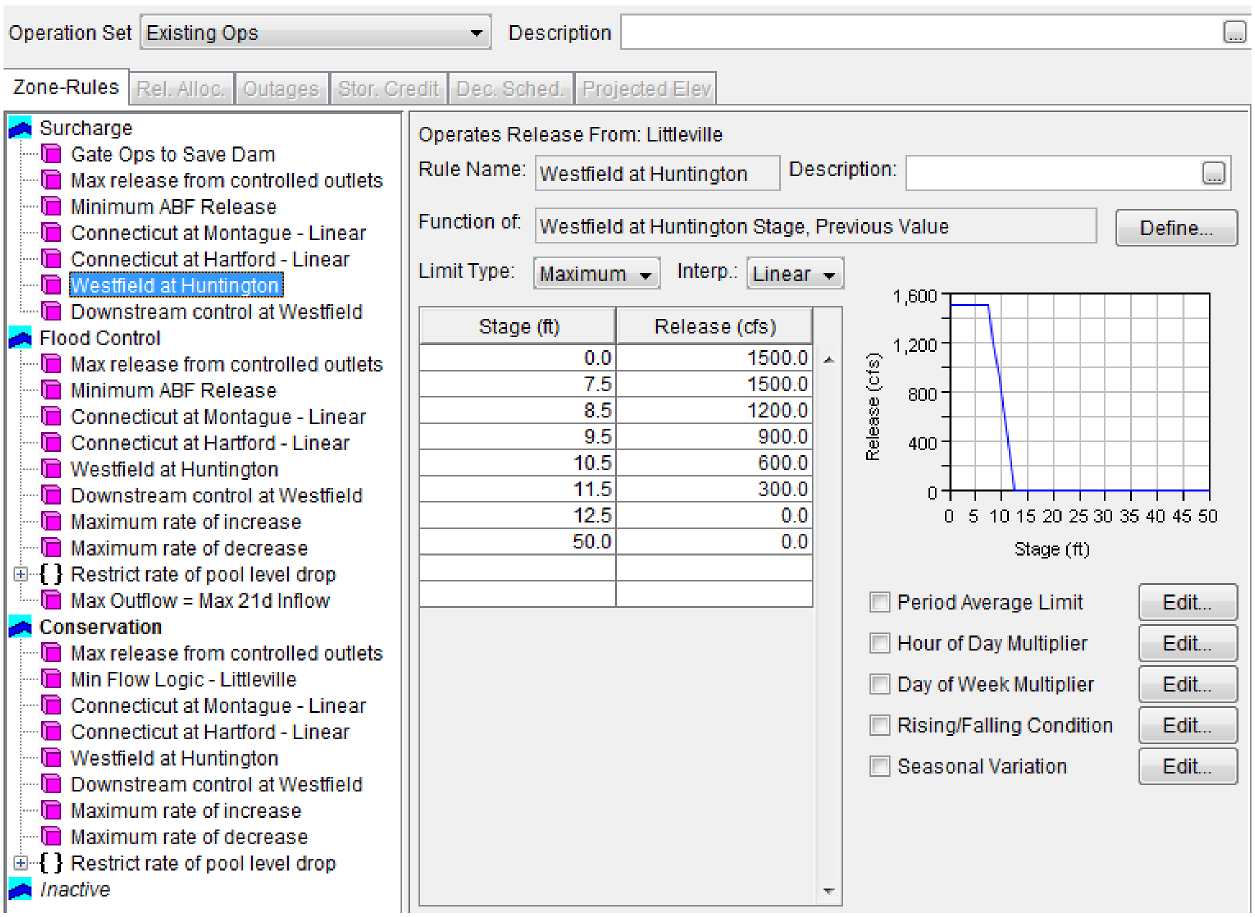


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet –Westfield at Huntington

7. Downstream control at Westfield

Figure 13 shows the content of “Downstream control at Westfield” rule. This rule represents the maximum allowable flow at the downstream point Westfield at Huntington.

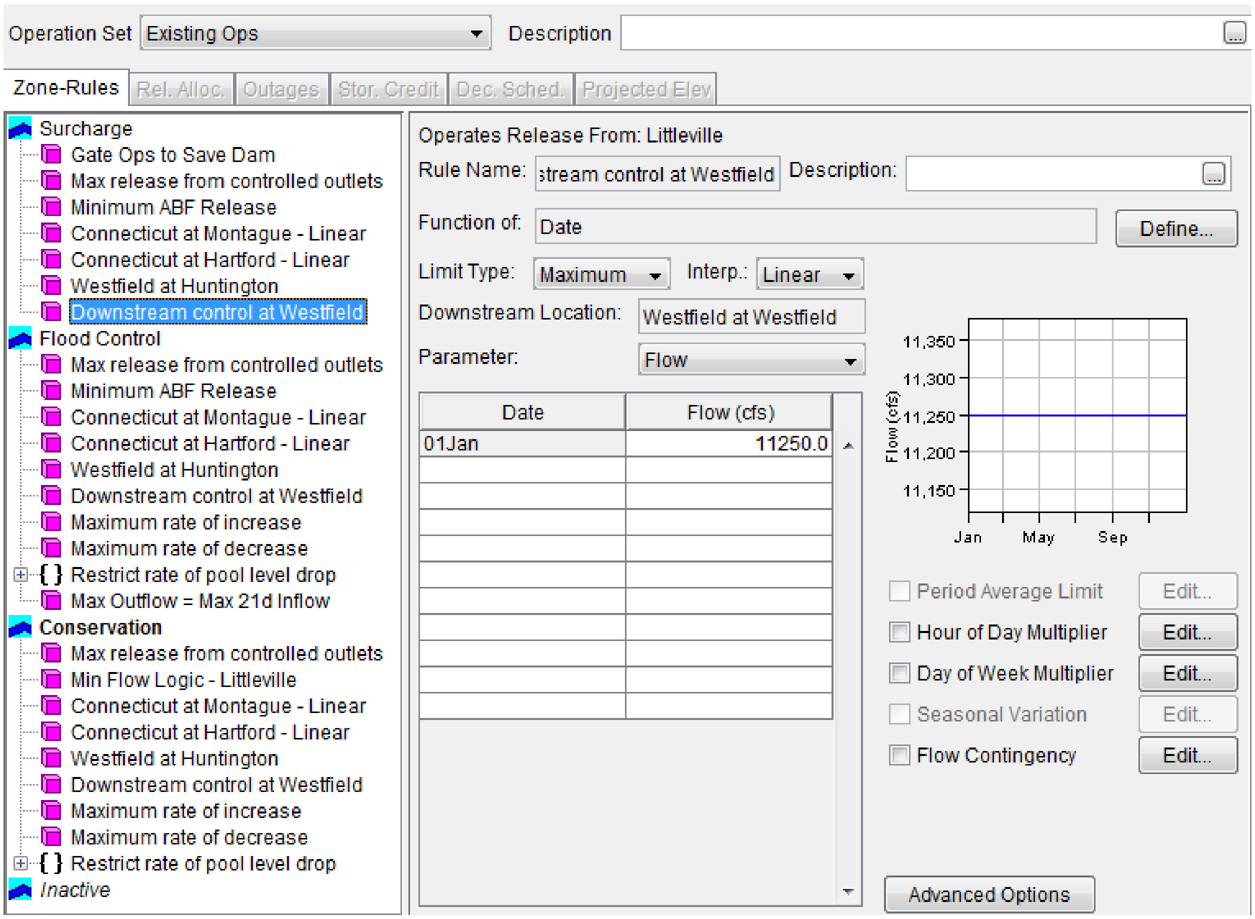
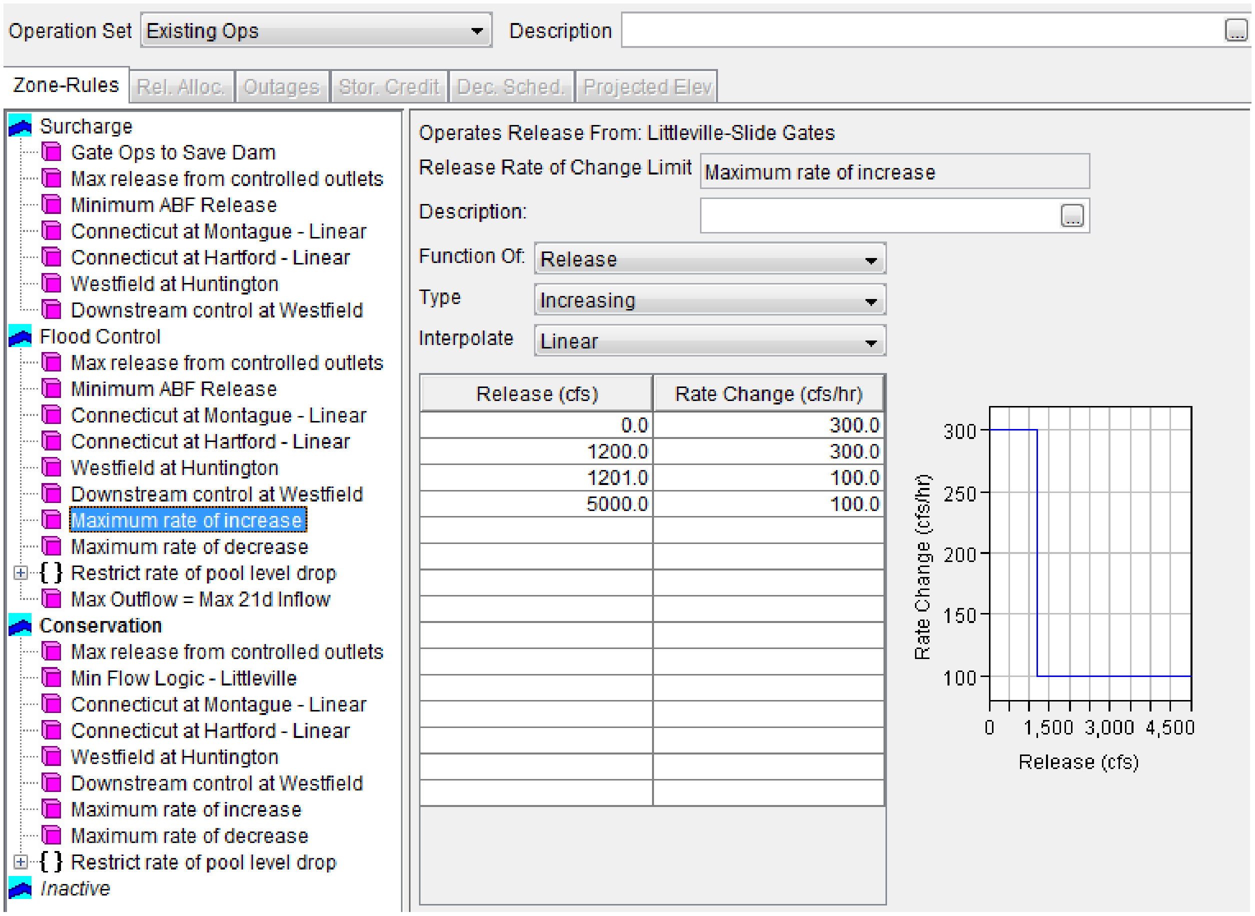


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet –Downstream control at Westfield

8. *Maximum rate of increase*

Figure 14 shows the content of "Maximum rate of increase" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Littleville dam.



Release (cfs)	Rate Change (cfs/hr)
0.0	300.0
1200.0	300.0
1201.0	100.0
5000.0	100.0

Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet –Maximum rate of increase

9. Maximum rate of decrease

Figure 15 shows the content of “Maximum rate of decrease” rule. This rule shows the maximum allowable decreasing release rate of change.

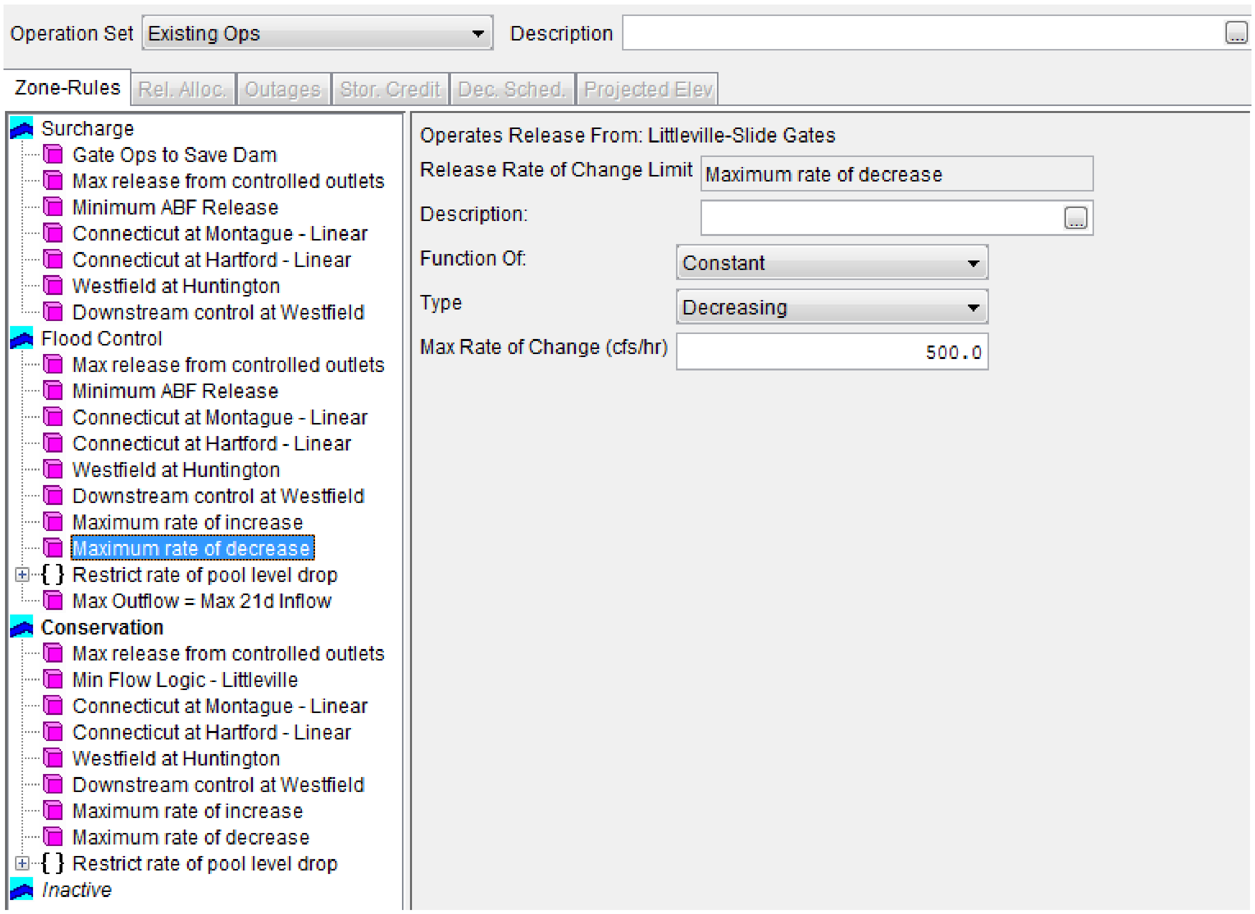
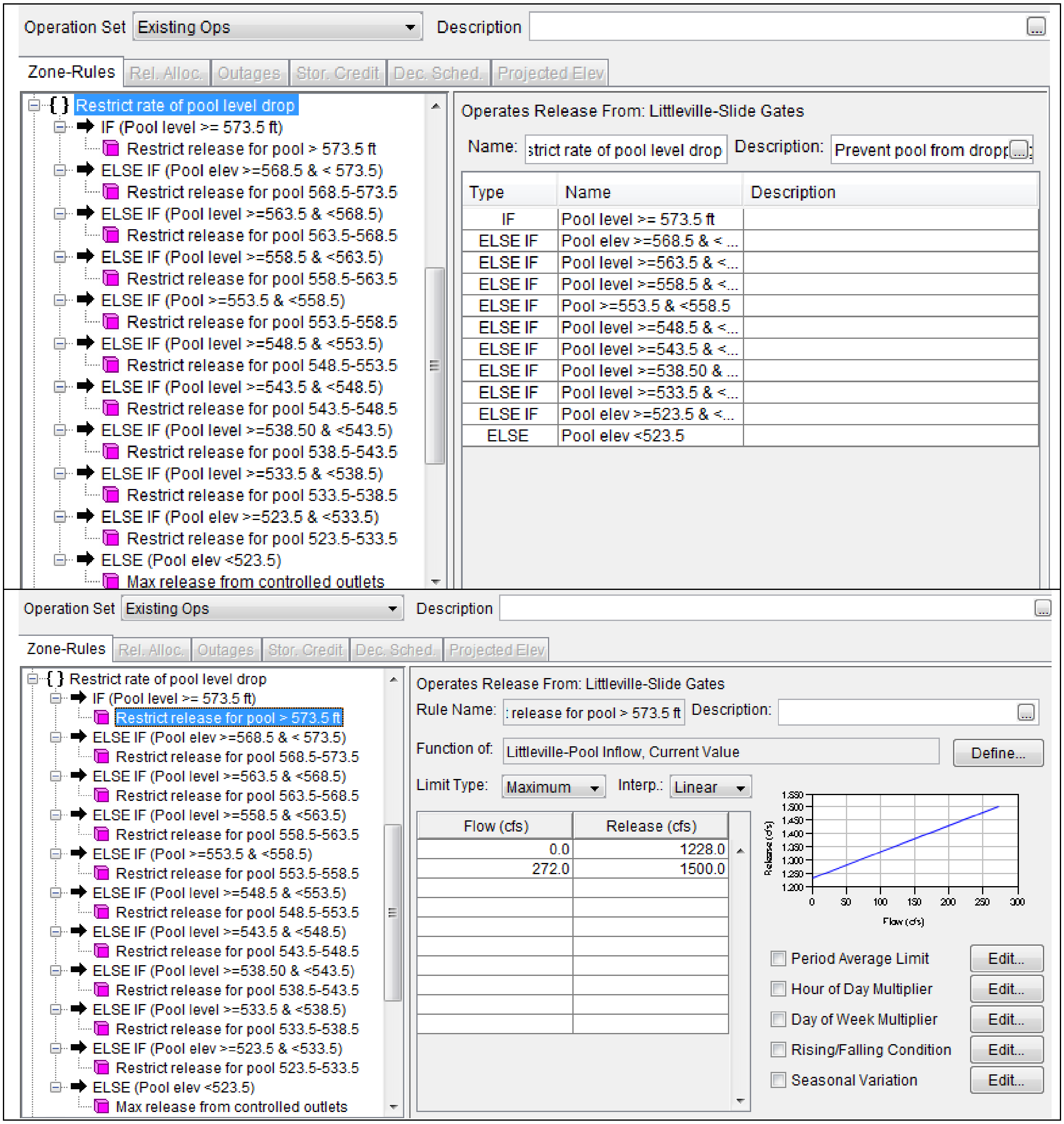
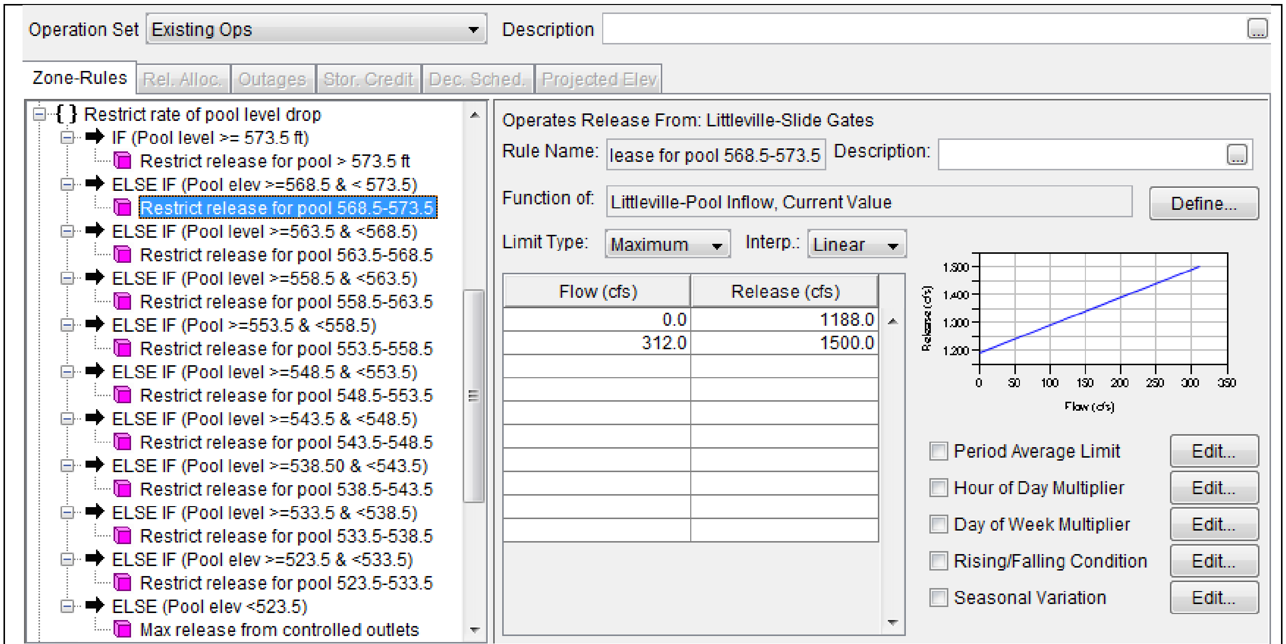


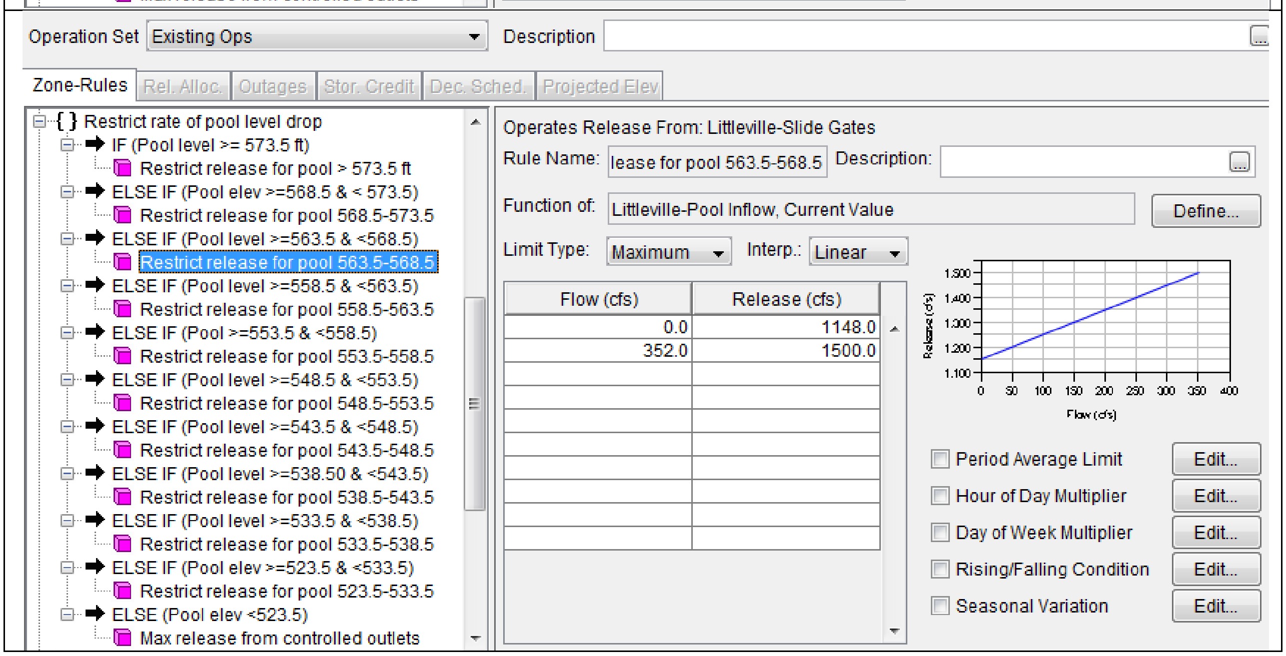
Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet –Maximum rate of decrease

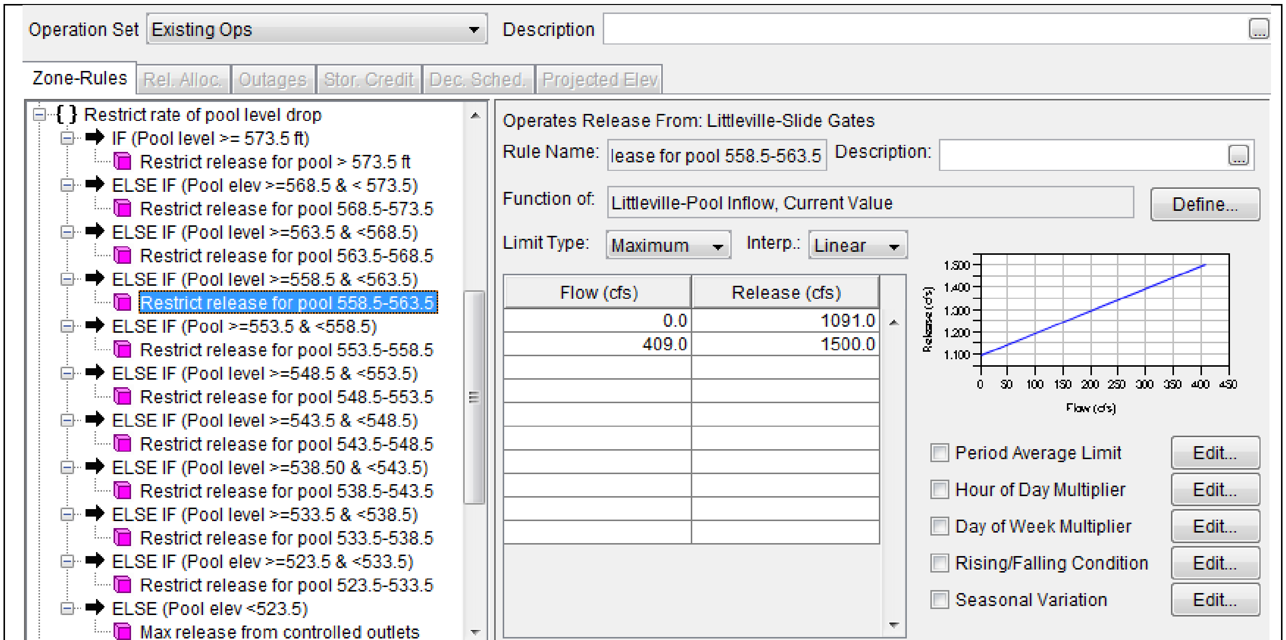
10. Restrict rate of pool level drop

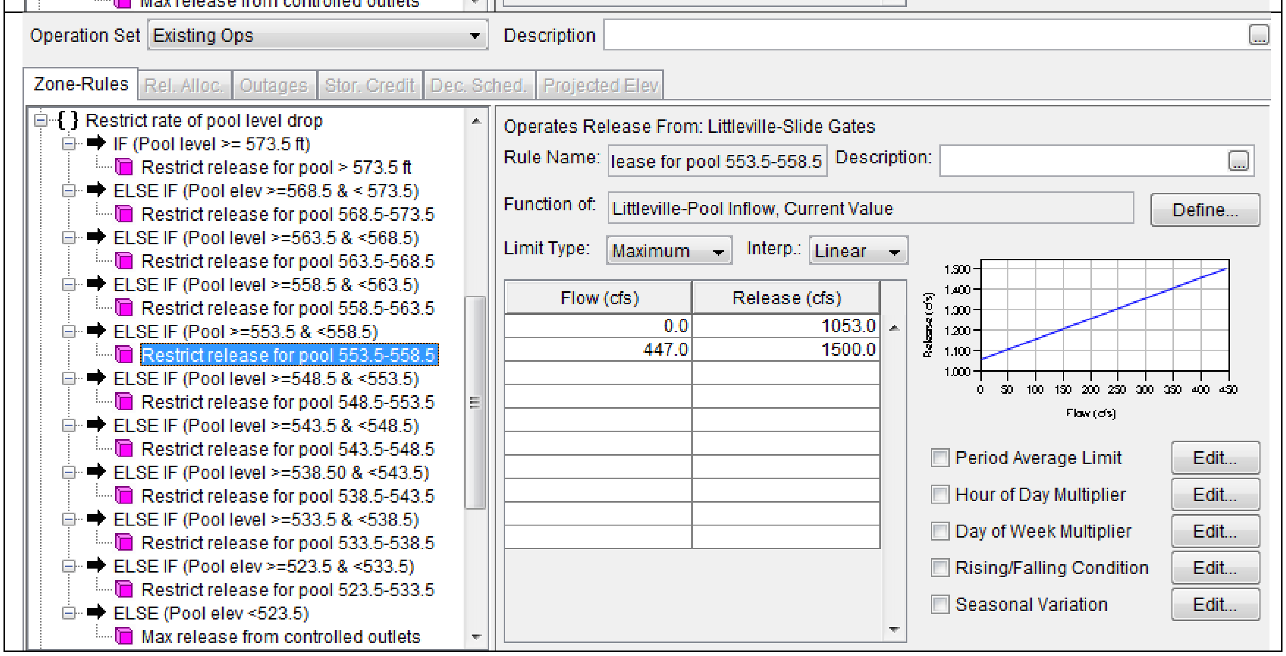
Figure 15 shows the content of “Restrict rate of pool level drop” rule. It shows the maximum allowable release as a function of Inflow for different ranges of pool elevations.

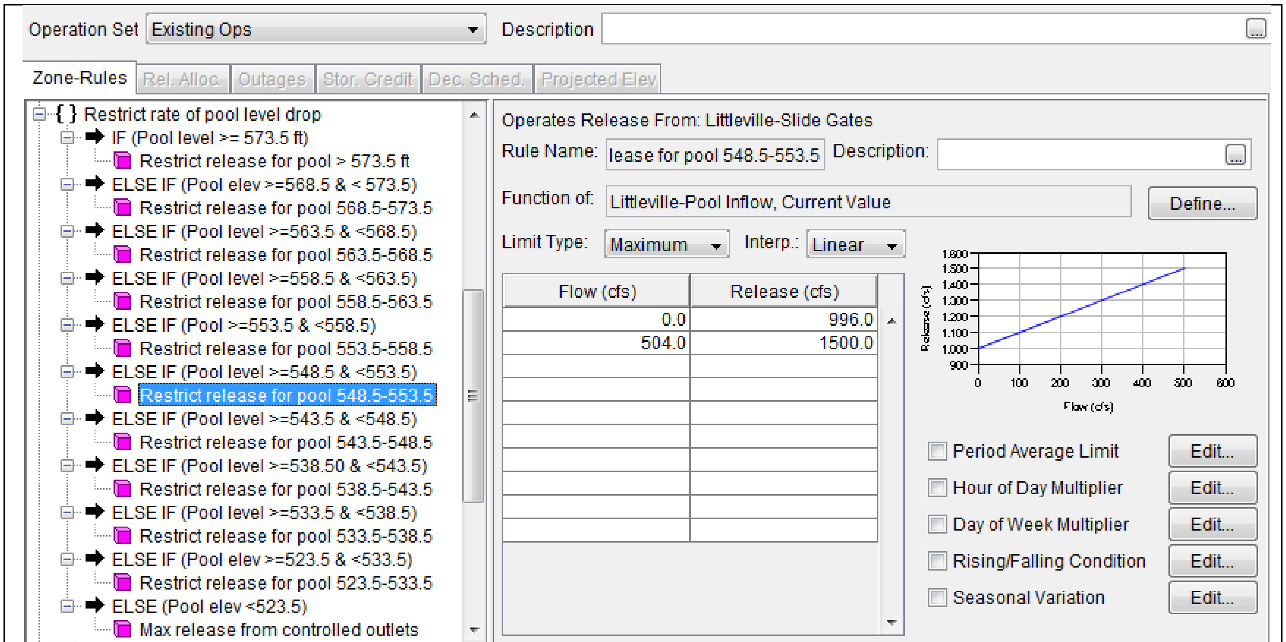


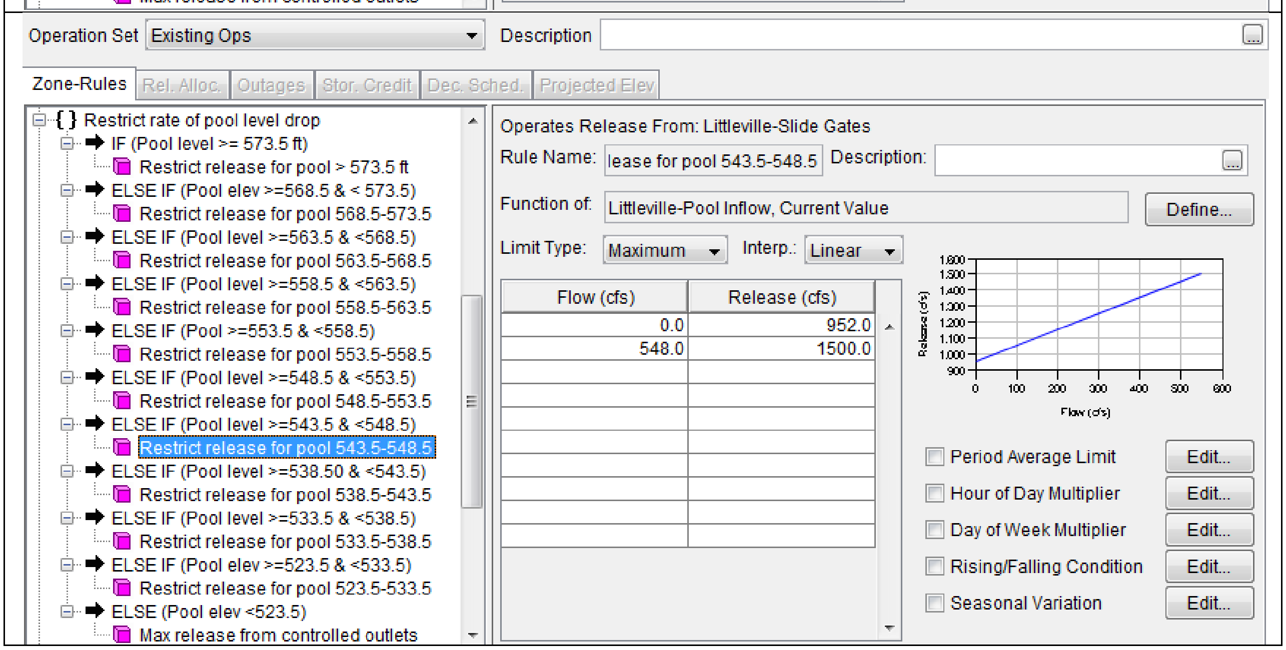


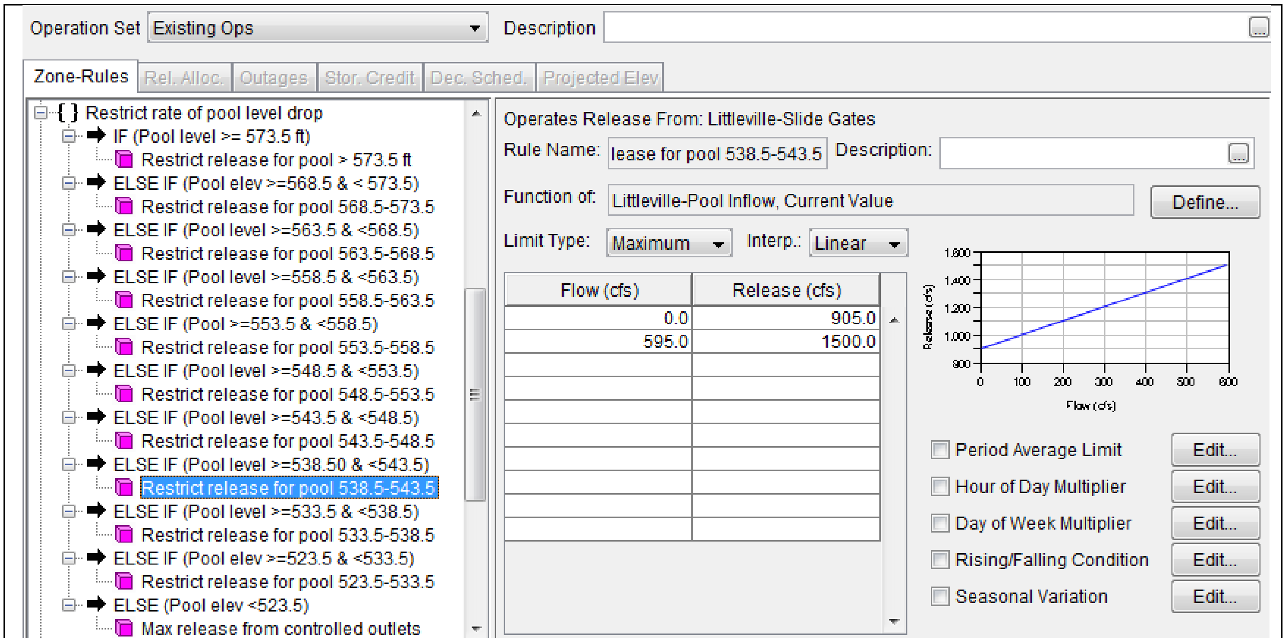


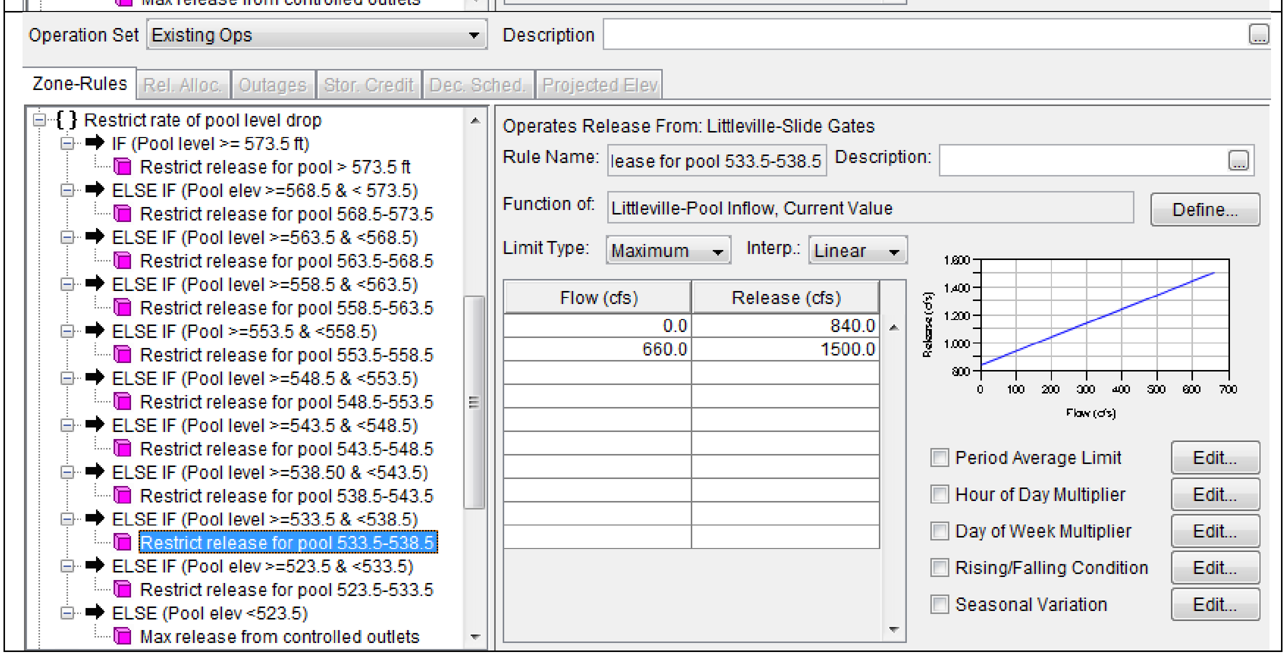

Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool level >= 573.5 ft)
Restrict release for pool > 573.5 ft
ELSE IF (Pool elev >=568.5 & < 573.5)
Restrict release for pool 568.5-573.5
ELSE IF (Pool level >=563.5 & <568.5)
Restrict release for pool 563.5-568.5
ELSE IF (Pool level >=558.5 & <563.5)
Restrict release for pool 558.5-563.5
ELSE IF (Pool >=553.5 & <558.5)
Restrict release for pool 553.5-558.5
ELSE IF (Pool level >=548.5 & <553.5)
Restrict release for pool 548.5-553.5
ELSE IF (Pool level >=543.5 & <548.5)
Restrict release for pool 543.5-548.5
ELSE IF (Pool level >=538.50 & <543.5)
Restrict release for pool 538.5-543.5
ELSE IF (Pool level >=533.5 & <538.5)
Restrict release for pool 533.5-538.5
ELSE IF (Pool elev >=523.5 & <533.5)
Restrict release for pool 523.5-533.5
ELSE (Pool elev <523.5)
Max release from controlled outlets
Operates Release From: Littleville-Slide Gates
Rule Name: lease for pool 558.5-563.5
Description:
Function of: Littleville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs) | Release (cfs)
0.0 | 1091.0
409.0 | 1500.0
Release (cfs)
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool level >= 573.5 ft)
Restrict release for pool > 573.5 ft
ELSE IF (Pool elev >=568.5 & < 573.5)
Restrict release for pool 568.5-573.5
ELSE IF (Pool level >=563.5 & <568.5)
Restrict release for pool 563.5-568.5
ELSE IF (Pool level >=558.5 & <563.5)
Restrict release for pool 558.5-563.5
ELSE IF (Pool >=553.5 & <558.5)
Restrict release for pool 553.5-558.5
ELSE IF (Pool level >=548.5 & <553.5)
Restrict release for pool 548.5-553.5
ELSE IF (Pool level >=543.5 & <548.5)
Restrict release for pool 543.5-548.5
ELSE IF (Pool level >=538.50 & <543.5)
Restrict release for pool 538.5-543.5
ELSE IF (Pool level >=533.5 & <538.5)
Restrict release for pool 533.5-538.5
ELSE IF (Pool elev >=523.5 & <533.5)
Restrict release for pool 523.5-533.5
ELSE (Pool elev <523.5)
Max release from controlled outlets
Operates Release From: Littleville-Slide Gates
Rule Name: lease for pool 553.5-558.5
Description:
Function of: Littleville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs) | Release (cfs)
0.0 | 1053.0
447.0 | 1500.0
Release (cfs)
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool level >= 573.5 ft)
Restrict release for pool > 573.5 ft
ELSE IF (Pool elev >=568.5 & < 573.5)
Restrict release for pool 568.5-573.5
ELSE IF (Pool level >=563.5 & <568.5)
Restrict release for pool 563.5-568.5
ELSE IF (Pool level >=558.5 & <563.5)
Restrict release for pool 558.5-563.5
ELSE IF (Pool >=553.5 & <558.5)
Restrict release for pool 553.5-558.5
ELSE IF (Pool level >=548.5 & <553.5)
Restrict release for pool 548.5-553.5
ELSE IF (Pool level >=543.5 & <548.5)
Restrict release for pool 543.5-548.5
ELSE IF (Pool level >=538.50 & <543.5)
Restrict release for pool 538.5-543.5
ELSE IF (Pool level >=533.5 & <538.5)
Restrict release for pool 533.5-538.5
ELSE IF (Pool elev >=523.5 & <533.5)
Restrict release for pool 523.5-533.5
ELSE (Pool elev <523.5)
Max release from controlled outlets
Operates Release From: Littleville-Slide Gates
Rule Name: lease for pool 548.5-553.5
Description:
Function of: Littleville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
996.0
504.0
1500.0
Release (cfs)
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool level >= 573.5 ft)
Restrict release for pool > 573.5 ft
ELSE IF (Pool elev >=568.5 & < 573.5)
Restrict release for pool 568.5-573.5
ELSE IF (Pool level >=563.5 & <568.5)
Restrict release for pool 563.5-568.5
ELSE IF (Pool level >=558.5 & <563.5)
Restrict release for pool 558.5-563.5
ELSE IF (Pool >=553.5 & <558.5)
Restrict release for pool 553.5-558.5
ELSE IF (Pool level >=548.5 & <553.5)
Restrict release for pool 548.5-553.5
ELSE IF (Pool level >=543.5 & <548.5)
Restrict release for pool 543.5-548.5
ELSE IF (Pool level >=538.50 & <543.5)
Restrict release for pool 538.5-543.5
ELSE IF (Pool level >=533.5 & <538.5)
Restrict release for pool 533.5-538.5
ELSE IF (Pool elev >=523.5 & <533.5)
Restrict release for pool 523.5-533.5
ELSE (Pool elev <523.5)
Max release from controlled outlets
Operates Release From: Littleville-Slide Gates
Rule Name: lease for pool 543.5-548.5
Description:
Function of: Littleville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
952.0
548.0
1500.0
Release (cfs)
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool level >= 573.5 ft)
Restrict release for pool > 573.5 ft
ELSE IF (Pool elev >=568.5 & < 573.5)
Restrict release for pool 568.5-573.5
ELSE IF (Pool level >=563.5 & <568.5)
Restrict release for pool 563.5-568.5
ELSE IF (Pool level >=558.5 & <563.5)
Restrict release for pool 558.5-563.5
ELSE IF (Pool >=553.5 & <558.5)
Restrict release for pool 553.5-558.5
ELSE IF (Pool level >=548.5 & <553.5)
Restrict release for pool 548.5-553.5
ELSE IF (Pool level >=543.5 & <548.5)
Restrict release for pool 543.5-548.5
ELSE IF (Pool level >=538.50 & <543.5)
Restrict release for pool 538.5-543.5
ELSE IF (Pool level >=533.5 & <538.5)
Restrict release for pool 533.5-538.5
ELSE IF (Pool elev >=523.5 & <533.5)
Restrict release for pool 523.5-533.5
ELSE (Pool elev <523.5)
Max release from controlled outlets
Operates Release From: Littleville-Slide Gates
Rule Name: lease for pool 538.5-543.5
Description:
Function of: Littleville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs) | Release (cfs)
0.0 | 905.0
595.0 | 1500.0
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
{ } Restrict rate of pool level drop
IF (Pool level >= 573.5 ft)
Restrict release for pool > 573.5 ft
ELSE IF (Pool elev >=568.5 & < 573.5)
Restrict release for pool 568.5-573.5
ELSE IF (Pool level >=563.5 & <568.5)
Restrict release for pool 563.5-568.5
ELSE IF (Pool level >=558.5 & <563.5)
Restrict release for pool 558.5-563.5
ELSE IF (Pool >=553.5 & <558.5)
Restrict release for pool 553.5-558.5
ELSE IF (Pool level >=548.5 & <553.5)
Restrict release for pool 548.5-553.5
ELSE IF (Pool level >=543.5 & <548.5)
Restrict release for pool 543.5-548.5
ELSE IF (Pool level >=538.50 & <543.5)
Restrict release for pool 538.5-543.5
ELSE IF (Pool level >=533.5 & <538.5)
Restrict release for pool 533.5-538.5
ELSE IF (Pool elev >=523.5 & <533.5)
Restrict release for pool 523.5-533.5
ELSE (Pool elev <523.5)
Max release from controlled outlets
Operates Release From: Littleville-Slide Gates
Rule Name: lease for pool 533.5-538.5
Description:
Function of: Littleville-Pool Inflow, Current Value
Define...
Limit Type: Maximum
Interp.: Linear
Flow (cfs) | Release (cfs)
0.0 | 840.0
660.0 | 1500.0
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

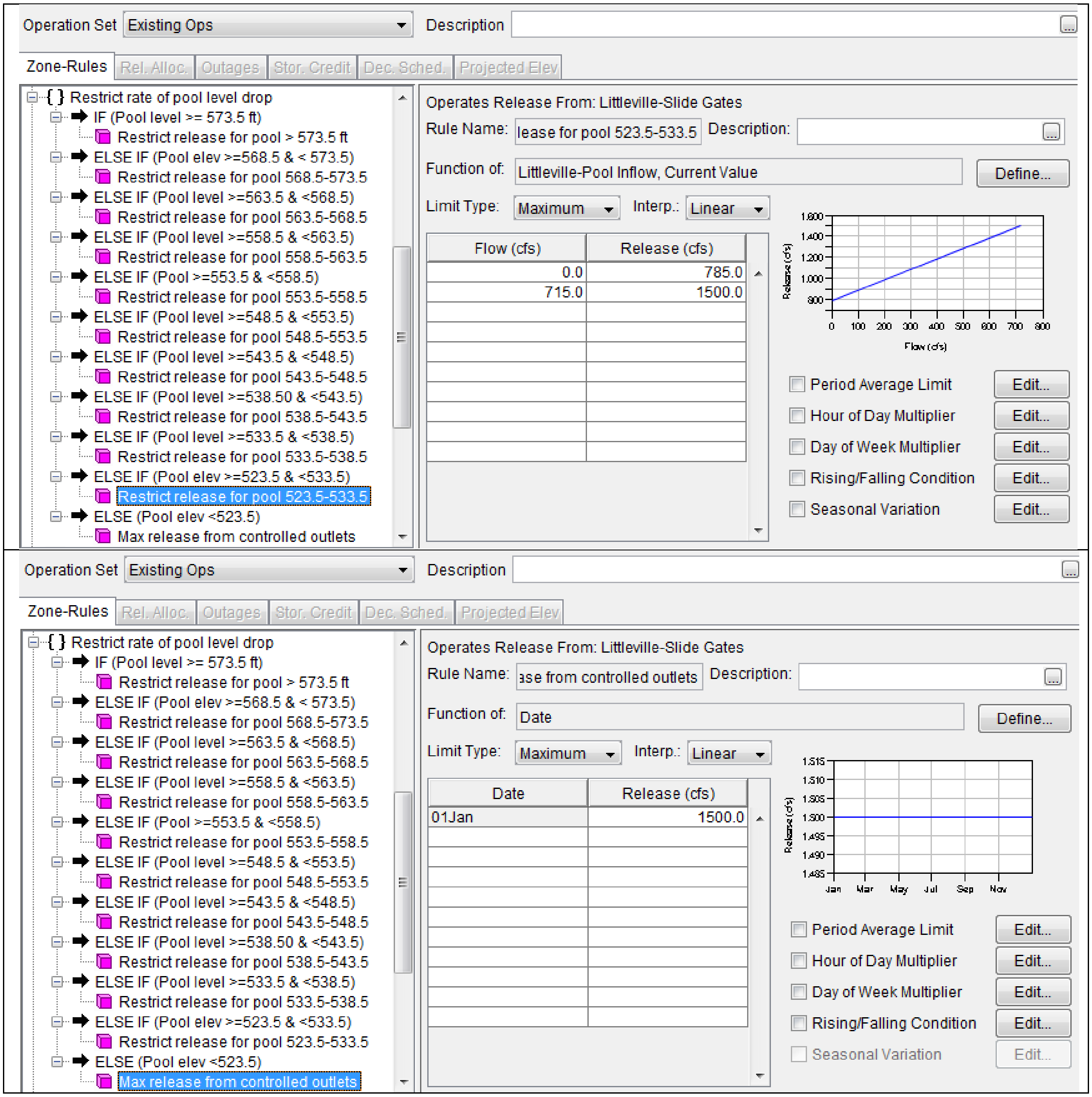


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet –Restrict rate of pool level drop

11. Max Outflow equals 21 day max Inflow

Figure 17 shows the content of “Max Outflow equals 21 day max Inflow” rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

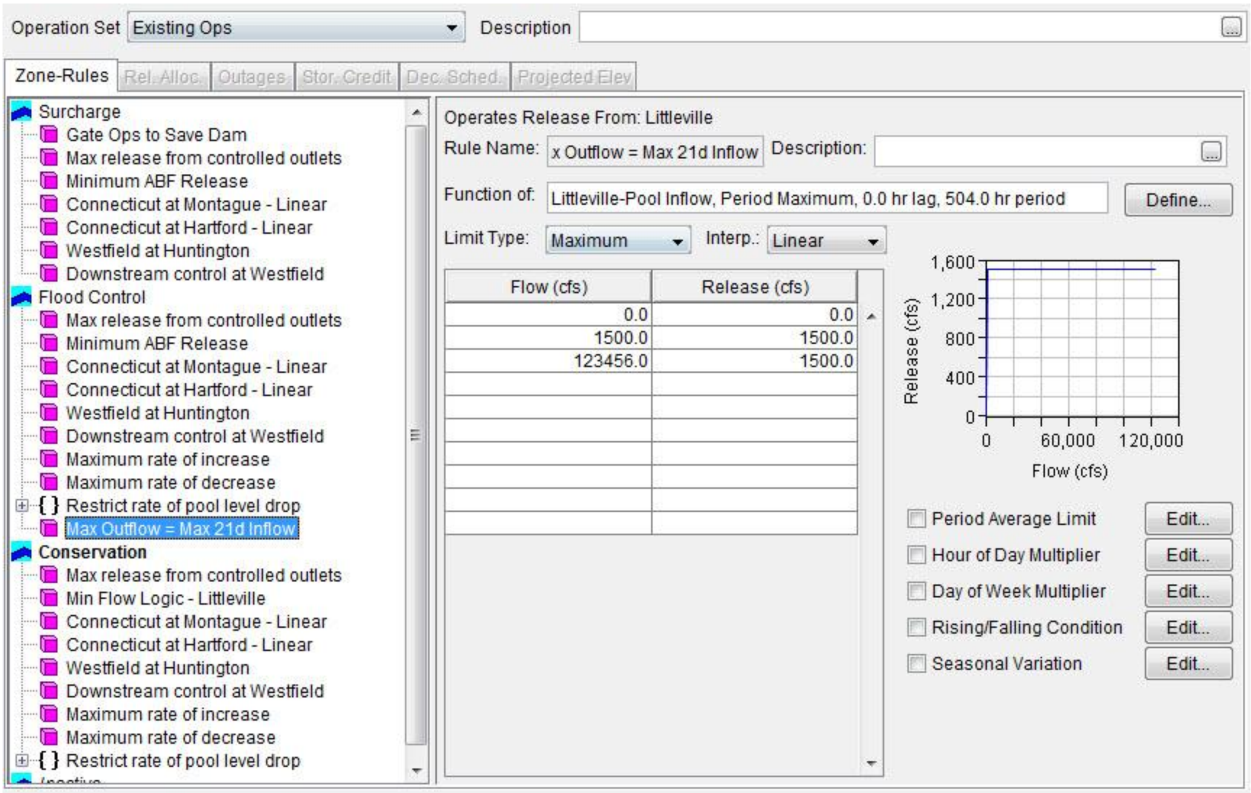


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals 21 day max Inflow

12. Min Flow Logic - Littleville

Figure 18 shows the content of “Min Flow Logic - Littleville” rule. This rule describes required seasonal minimum flows from controlled outlets as a function of inflow at Littleville.

.

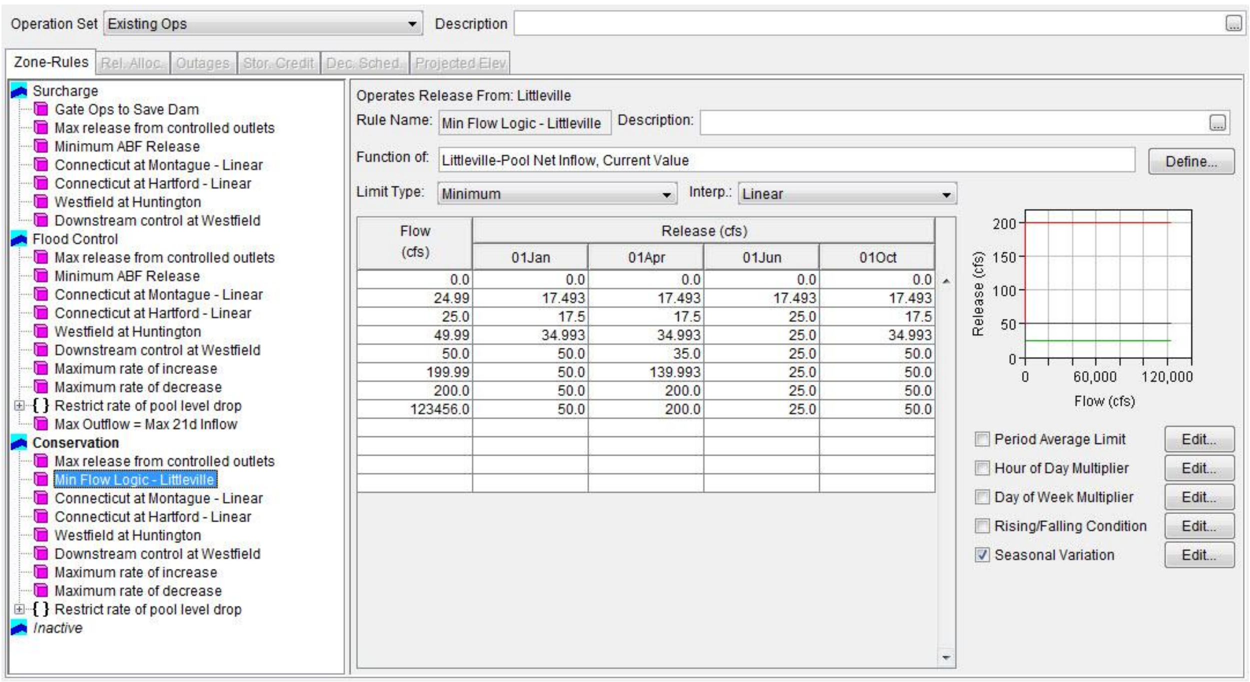


Figure 18: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic - Littleville

Mare Meadow

I. Overview

Mare Meadow dam is on the Mare Meadow River in Worcester County, Massachusetts. It is owned by the City Of Fitchburg and is primarily used for drinking water supply for the city.

Figure 1 shows the location of Mare Meadow Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the dam.

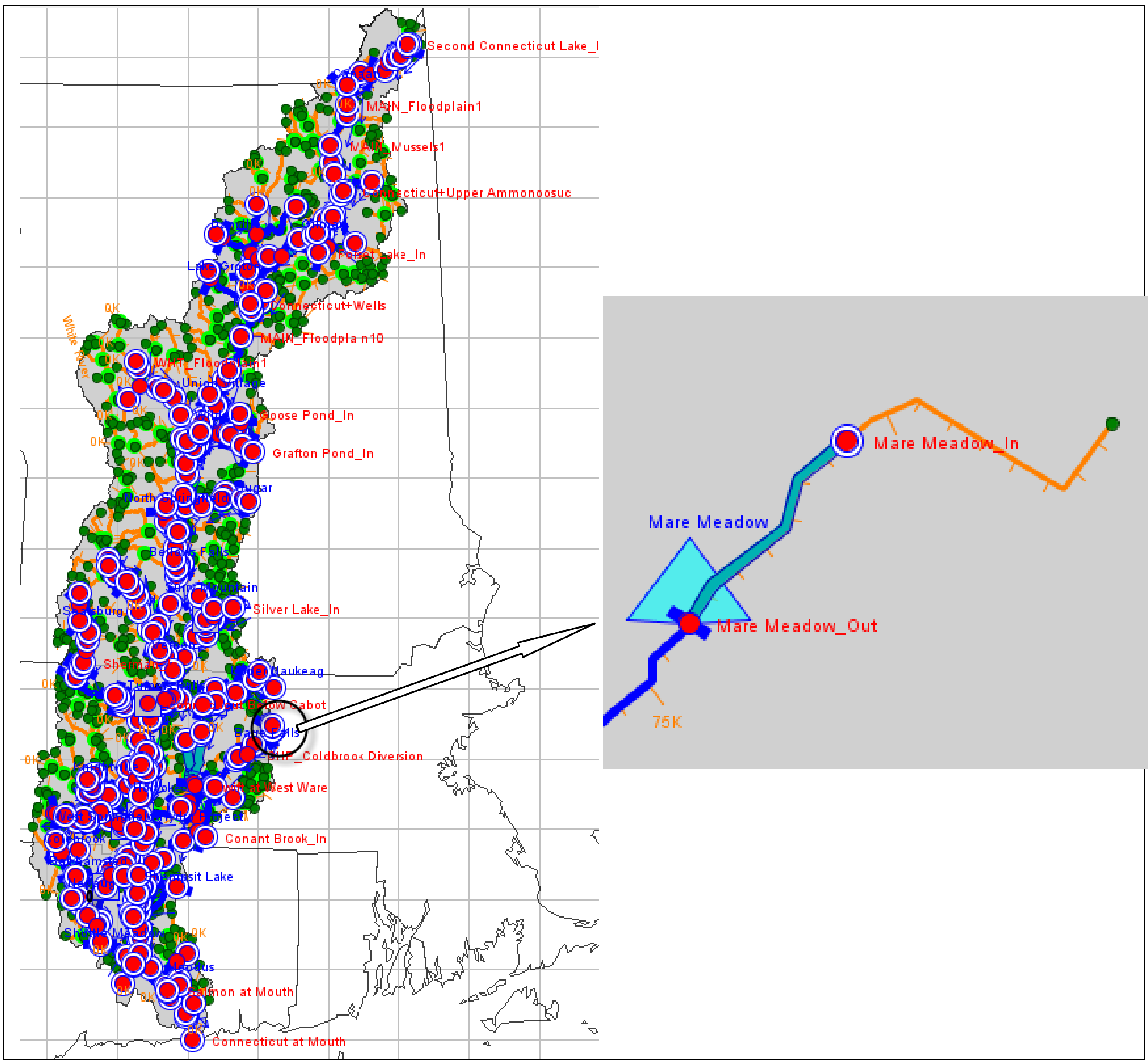


Figure 1: HEC-ResSim Map Display Showing Location of Mare Meadow

Figure 2: Aerial photo of Mare Meadow reservoir.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[59]. The dam consists of a controlled outlet and an uncontrolled spillway as shown in Figure 4.

[59] Provided by UMASS

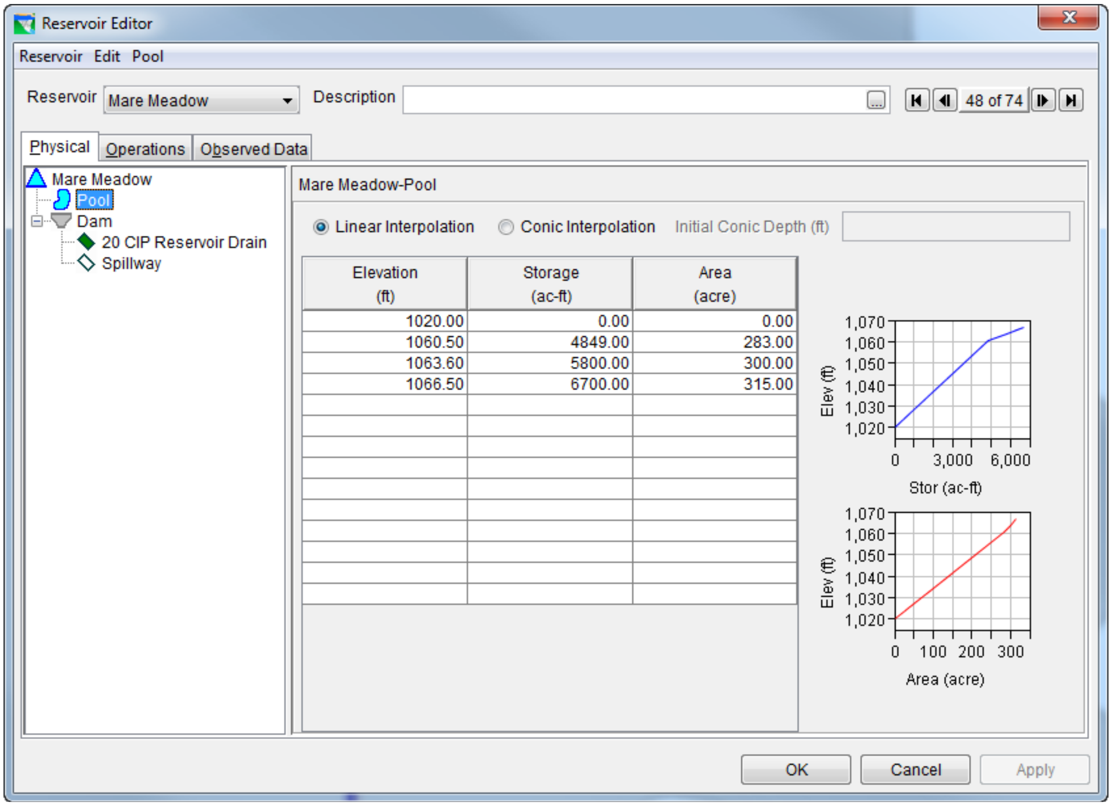


Figure 3: Reservoir Editor: Physical Tab -- Pool

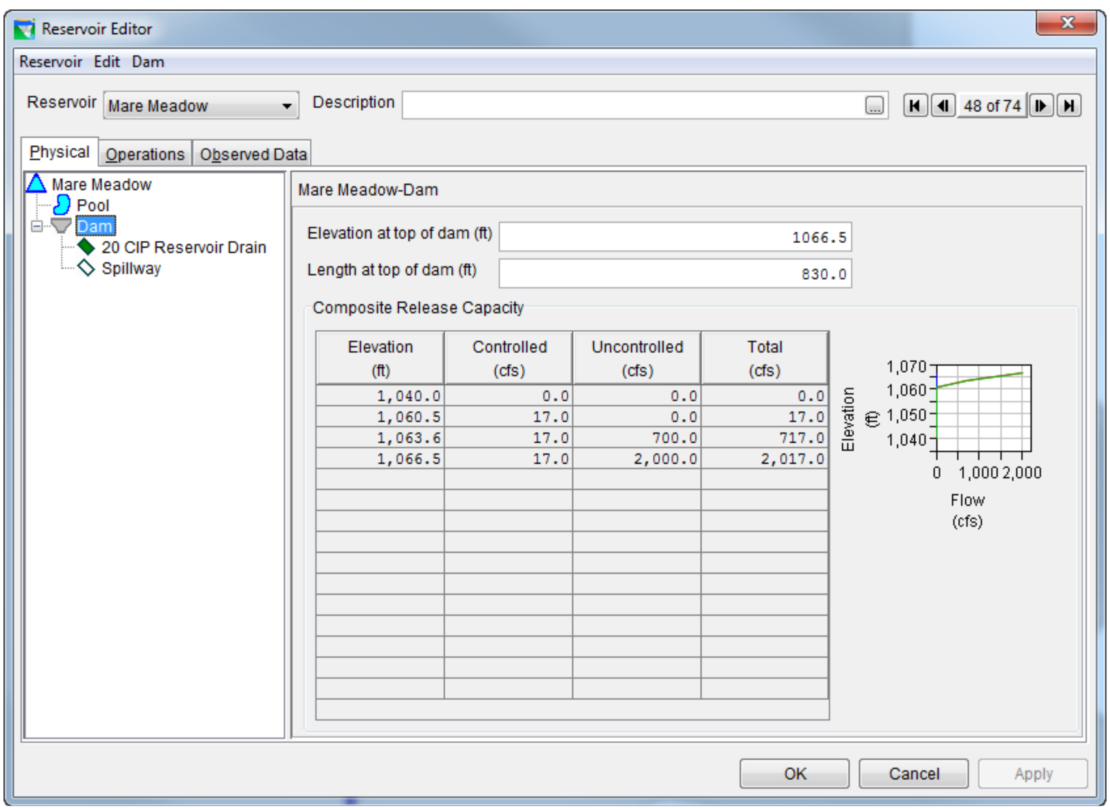


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Mare Meadow's "Existing Ops" operational zones, which consist of zones of Flood Control (1066.5 ft), Conservation (1060.5 ft), and Inactive zone (1020 ft)[1].

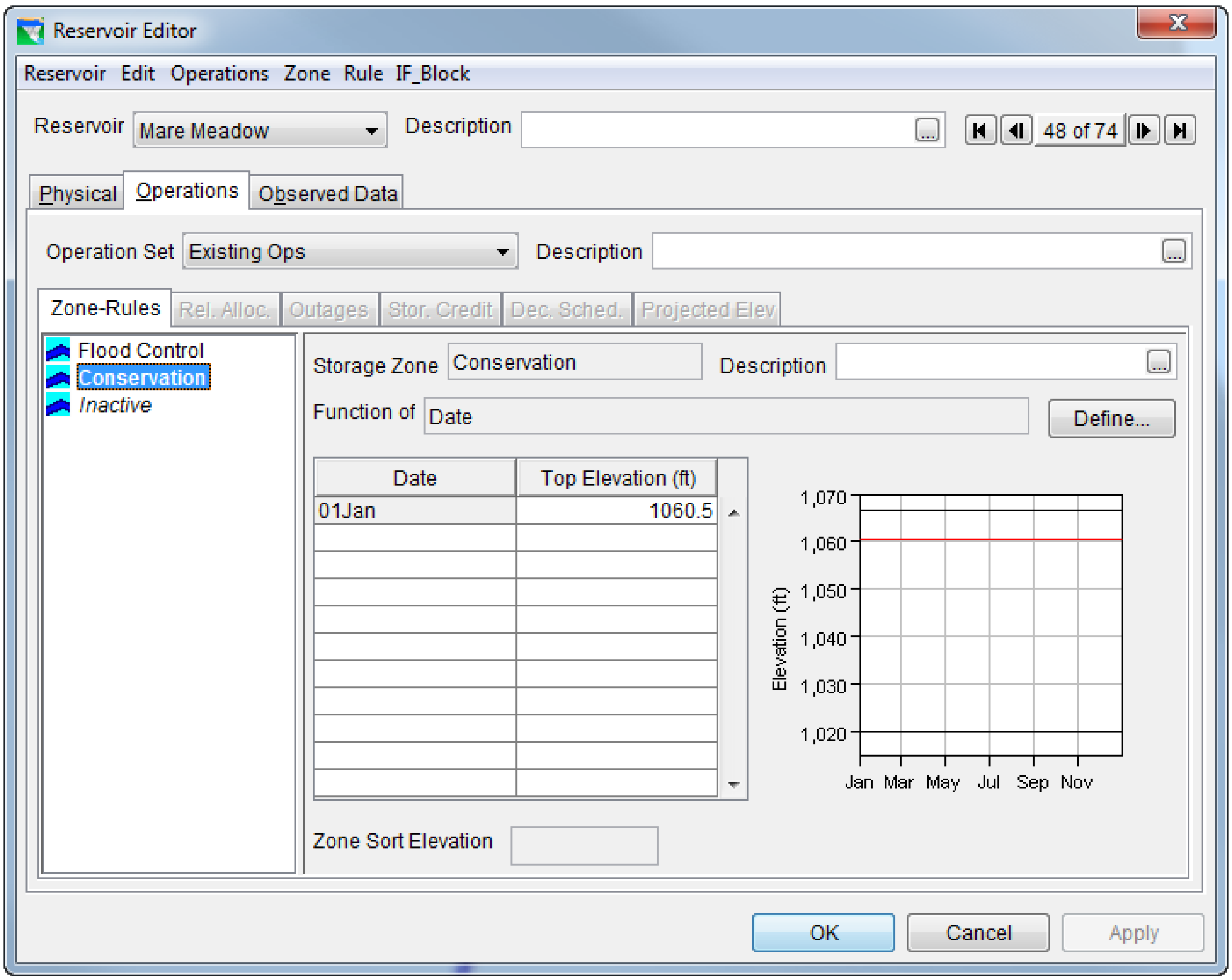


Figure 5: Reservoir Editor: Operations Tab – Existing Ops OpSet

B. Rule Illustrations

The operation set for Mare Meadow has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Mascoma

I. Overview

Mascoma Lake dam is located 3 miles upstream of the city of Lebanon on the Mascoma River. It is currently owned and operated by the New Hampshire Water Resources Board and is used for several purposes: water supply for the City of Lebanon, recreation, and some flood control.

Figure 1 shows the location of Mascoma dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Mascoma dam.

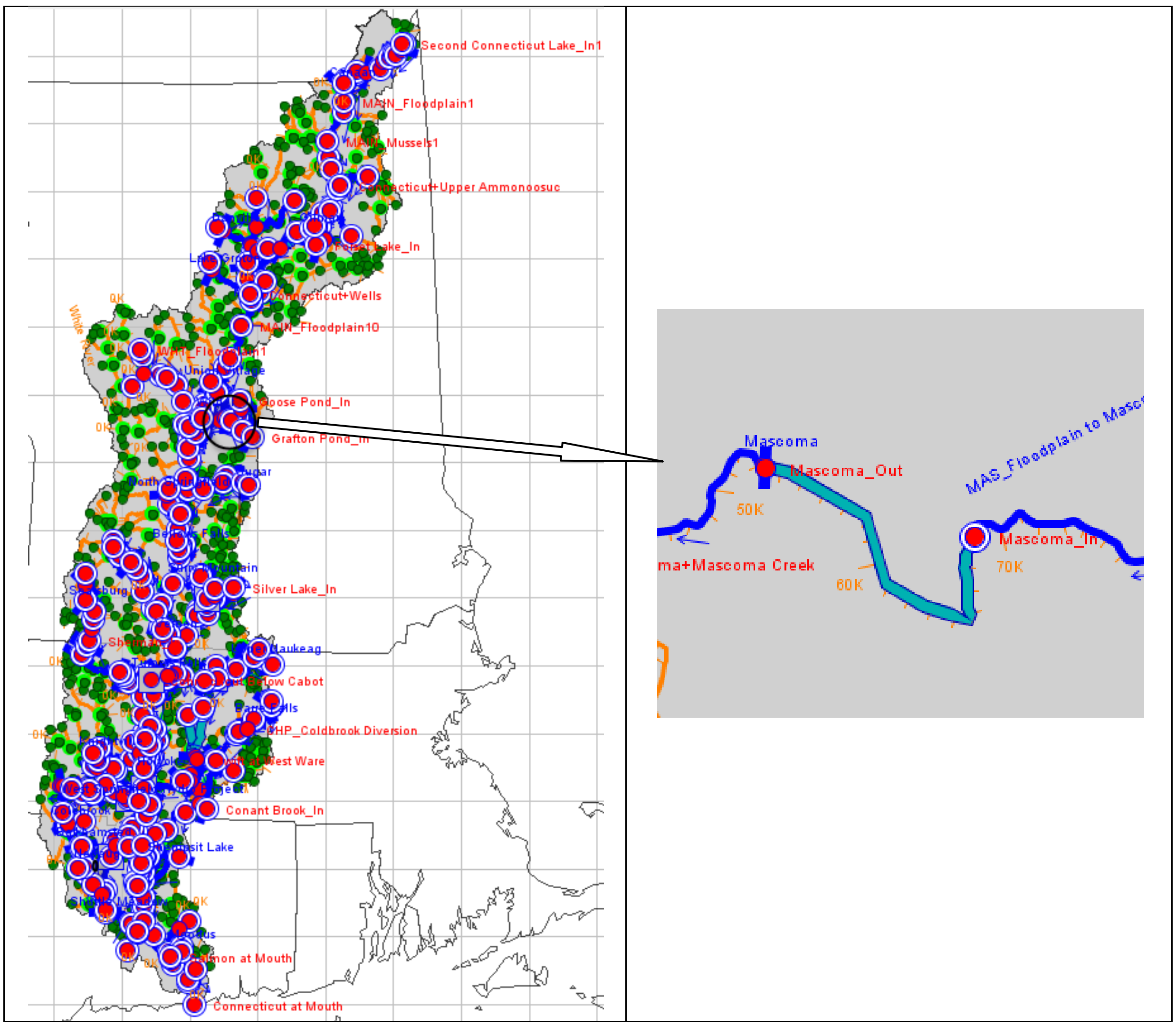


Figure 1: HEC-ResSim Map Display Showing Location of Mascoma Dam

Figure 2: Photo of Mascoma dam.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[60]. The dam consists of three types of outlets: (1) controlled slide gates, (2) controlled Obermeyer gate on aux spillway, and (3) uncontrolled Main Spillway, as shown in Figure 4[61].

[60] NHDams Data Sheet. Mascoma Dam. 2010
[61] Phase 1 Report. Mascoma Dam. 1978.

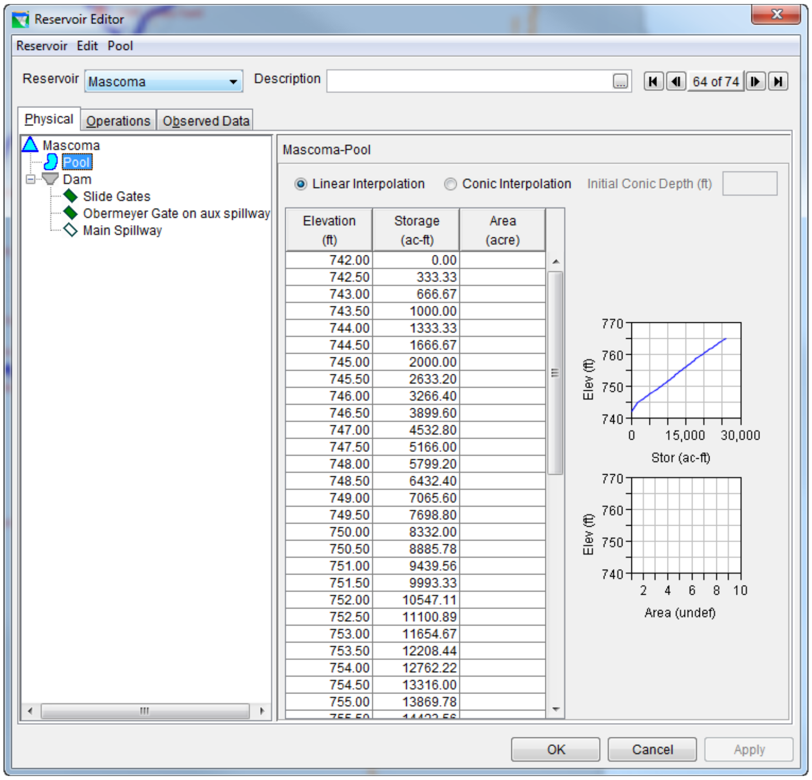


Figure 3: Reservoir Editor: Physical Tab – Pool

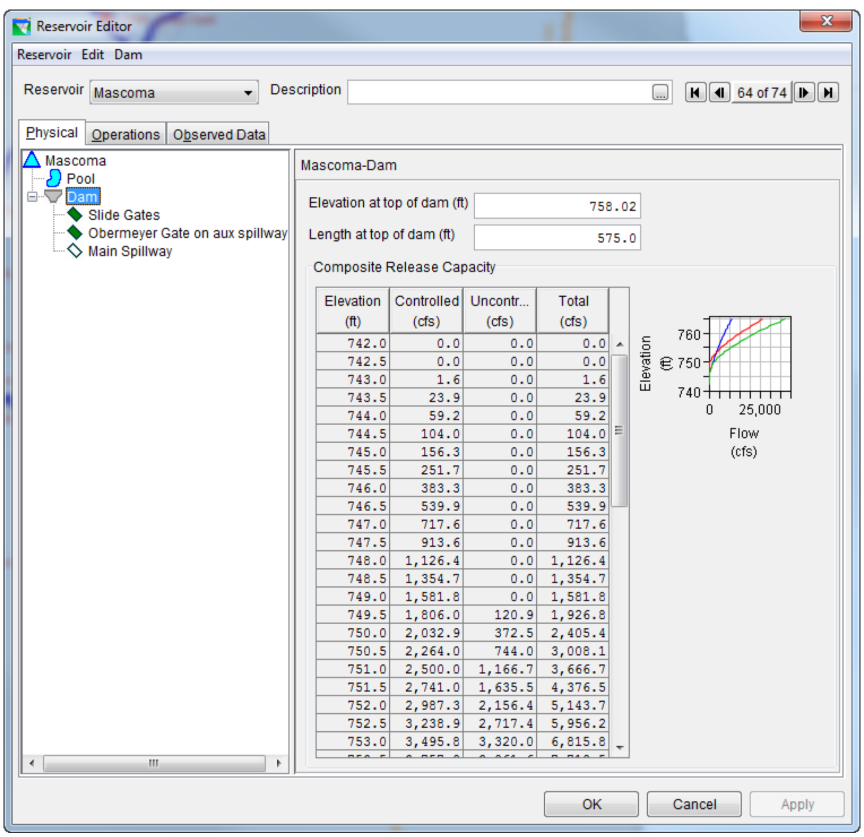


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Mascoma Dam's "ExistingOps" operational zones, which consist of zones of Flood Control (758.02 ft), Conservation (748-751 ft), and Inactive zone (742 ft)[62].

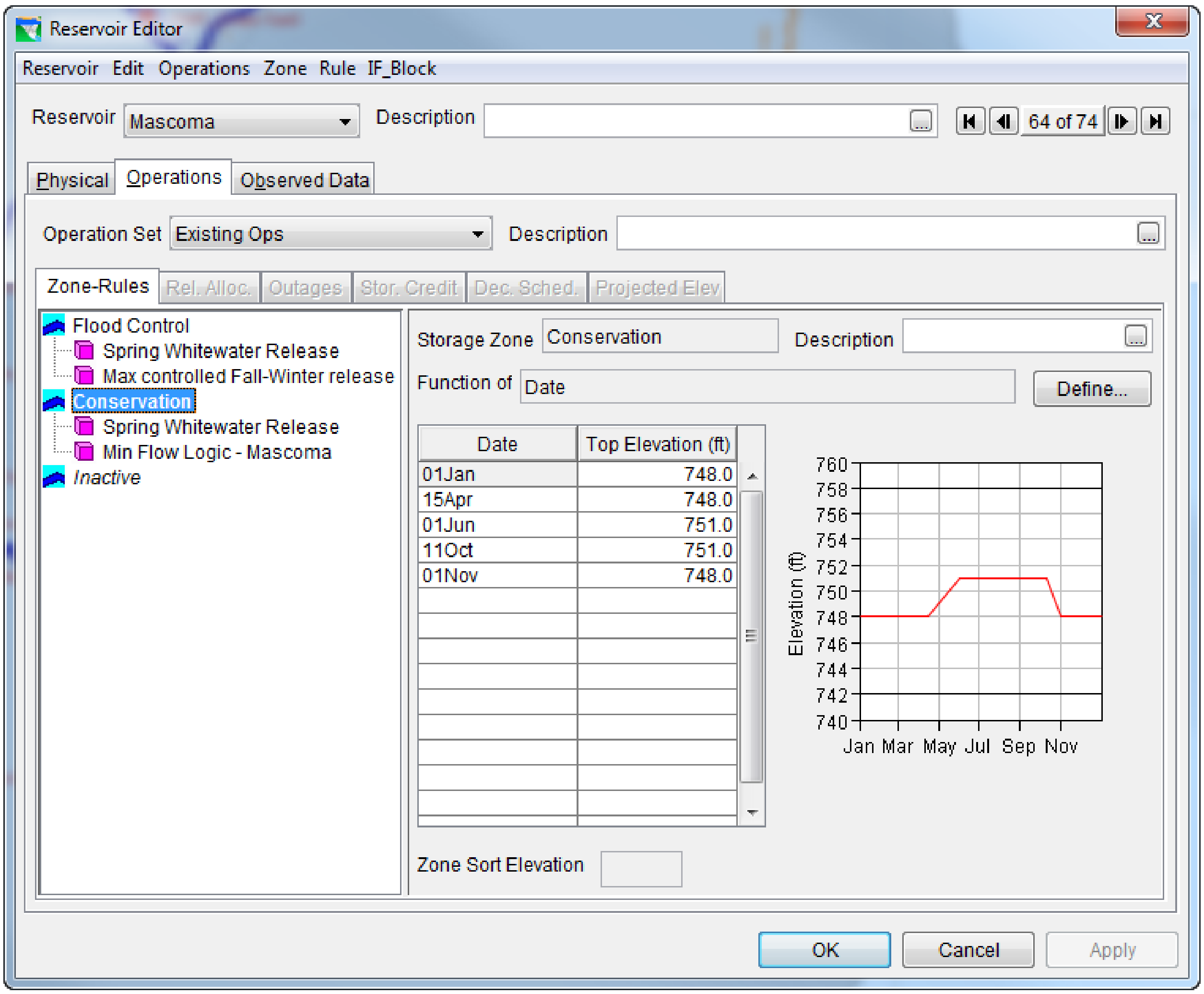


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

[62] http://www2.des.state.nh.us/rti_home/station_information_display.asp?WID=fivebasins&ID=MCAN3&NAME=Mascoma+Lake

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[63].

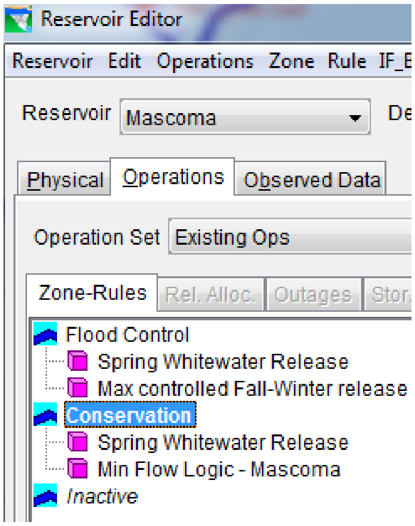


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. *Spring Whitewater release*

Figure 7 shows the content of "Spring Whitewater Release" rule. This rule defines a seasonal maximum release from reservoir as a function of Inflow.

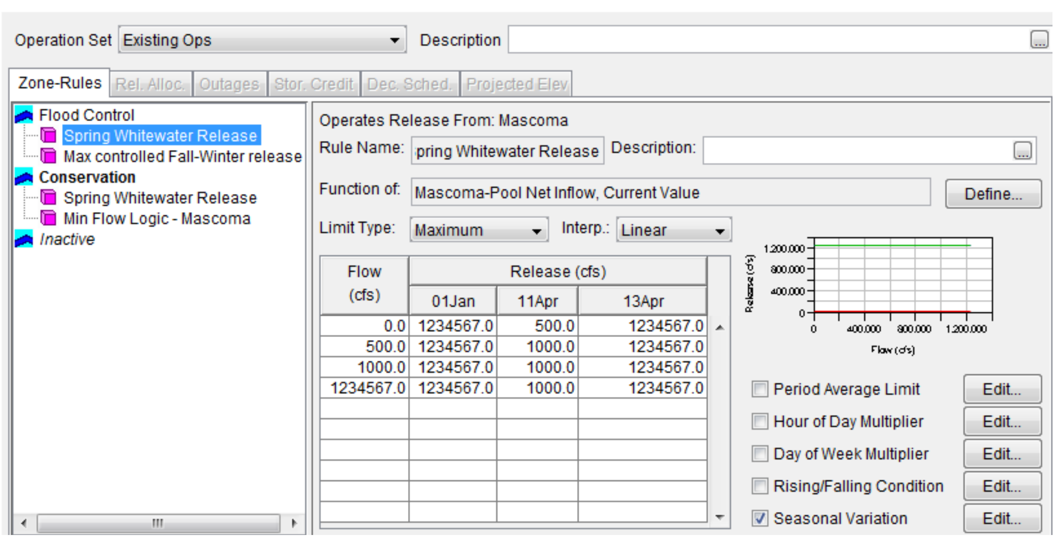


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Spring Whitewater Release

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[63] Mascoma Lake Operating Guide. 1985.

2. *Max controlled Fall-Winter release*

Figure 8 shows the content of "Max controlled Fall-Winter release" rule. This rule limits the maximum release from Dam to 2000 cfs during 15Apr-31May.

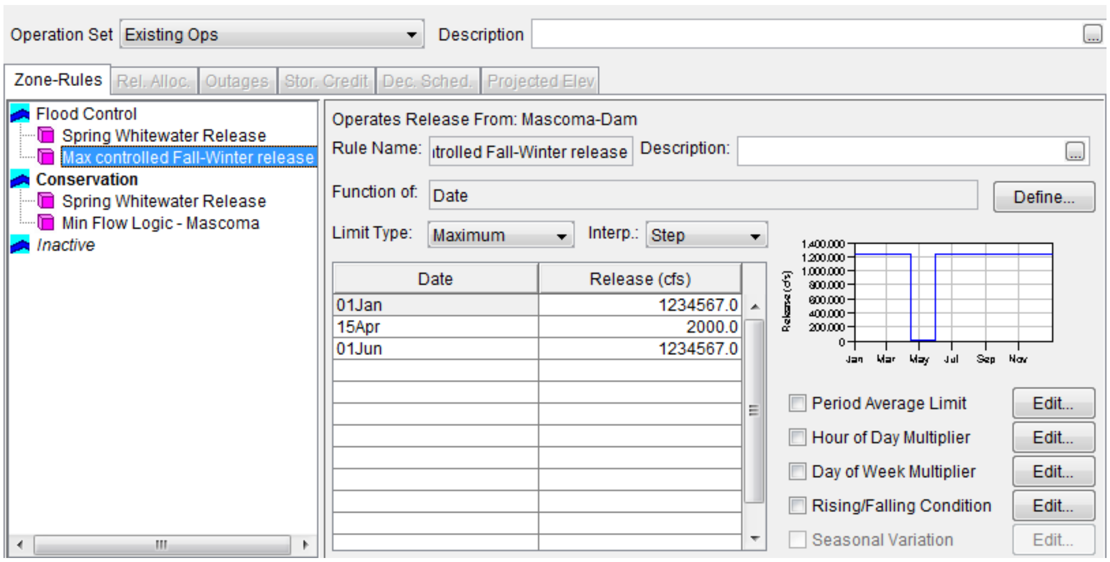


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max controlled Fall-Winter release

3. *Min Flow logic-Mascoma*

Figure 9 shows the content of "Min Flow logic-Mascoma" rule. This rule represents the seasonal minimum flow from reservoir as a function of Inflow.

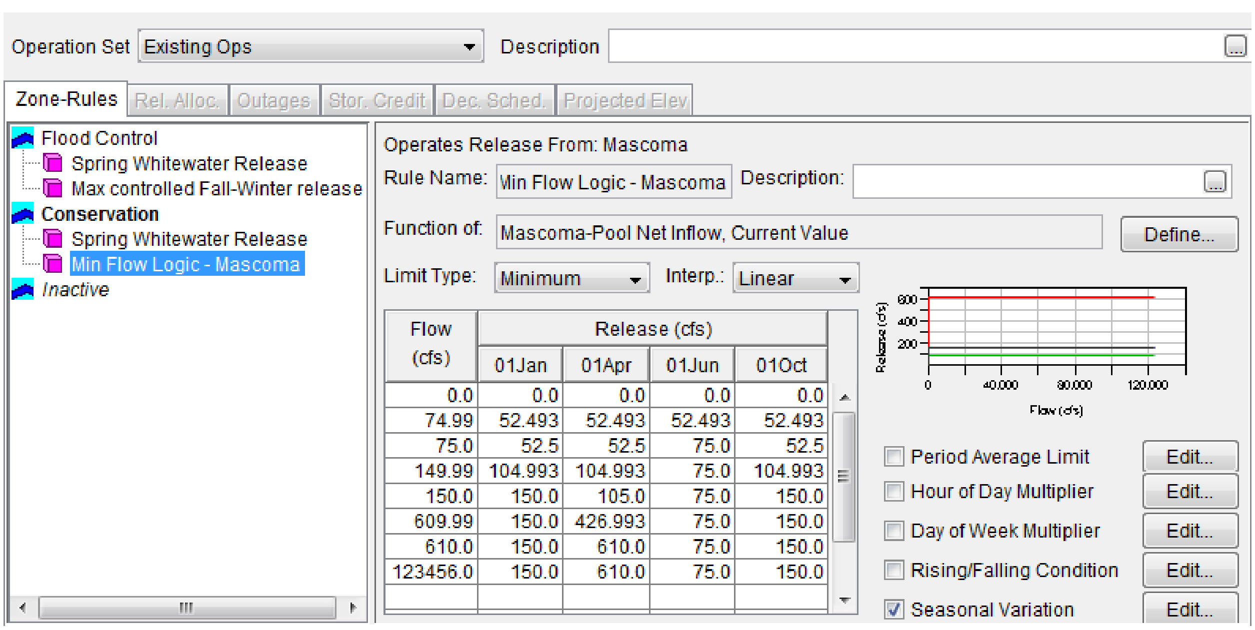


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow logic-Mascoma

McIndoes

I. Overview

McIndoes dam is located on the mainstem Connecticut River between Monroe, NH and Barnet, VT. It is owned and operated by TransCanada Hydro Northeast Inc. as part of the 15 Mile Falls project for hydropower generation on run-of-river basis.

Figure 1 shows the location of McIndoes dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of McIndoes dam.

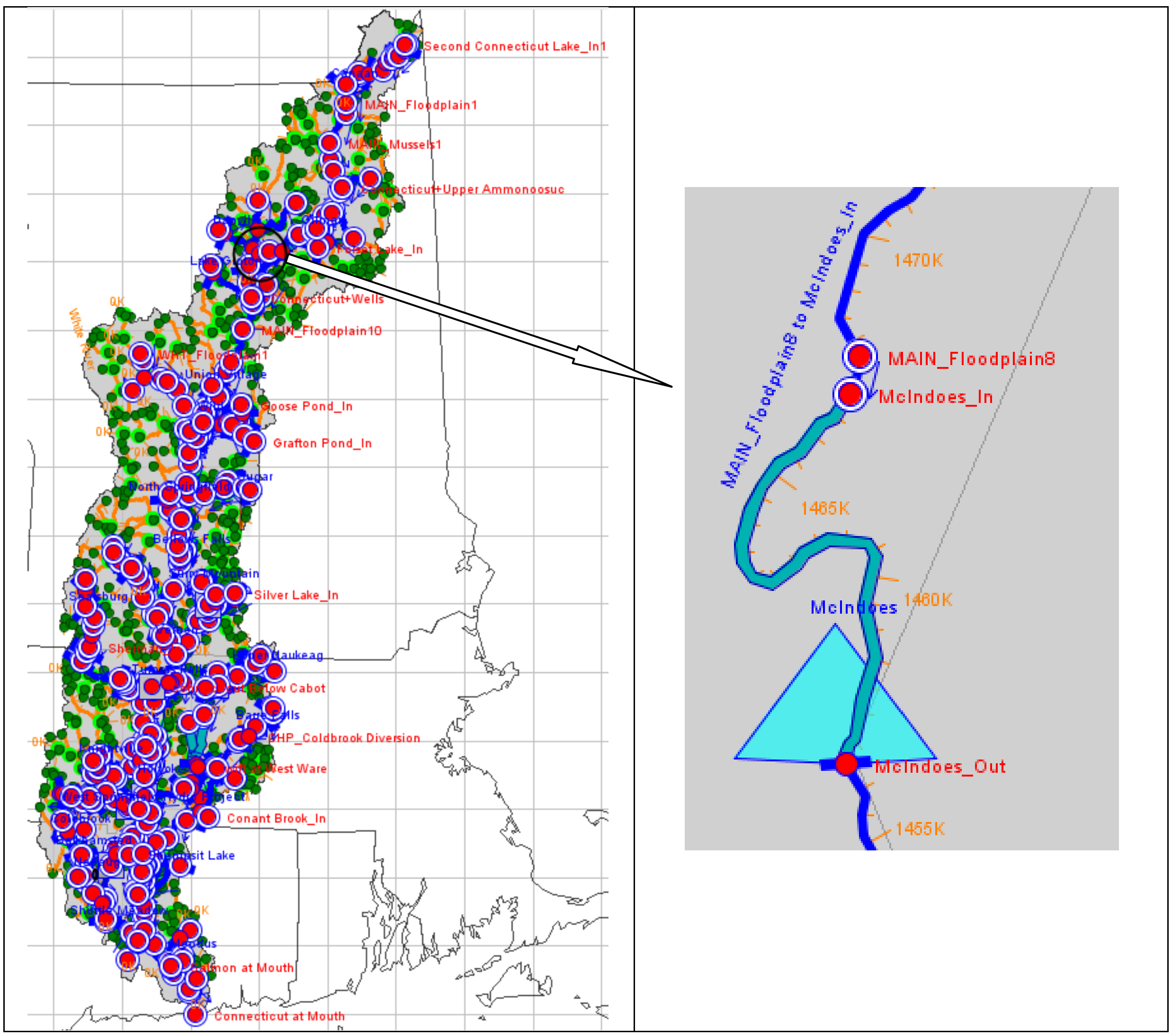


Figure 1: HEC-ResSim Map Display Showing Location of McIndoes dam

Figure 2: Photo of McIndoes Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[64]. The dam consists of six types of outlets: (1) uncontrolled outlet, (2) controlled skimmer gate, (3) controlled tainter gate, (4) controlled needle flashboard, (5) controlled pin flashboard, (6) and power plant as shown in Figure 4.

[64] Data provided by TransCanada

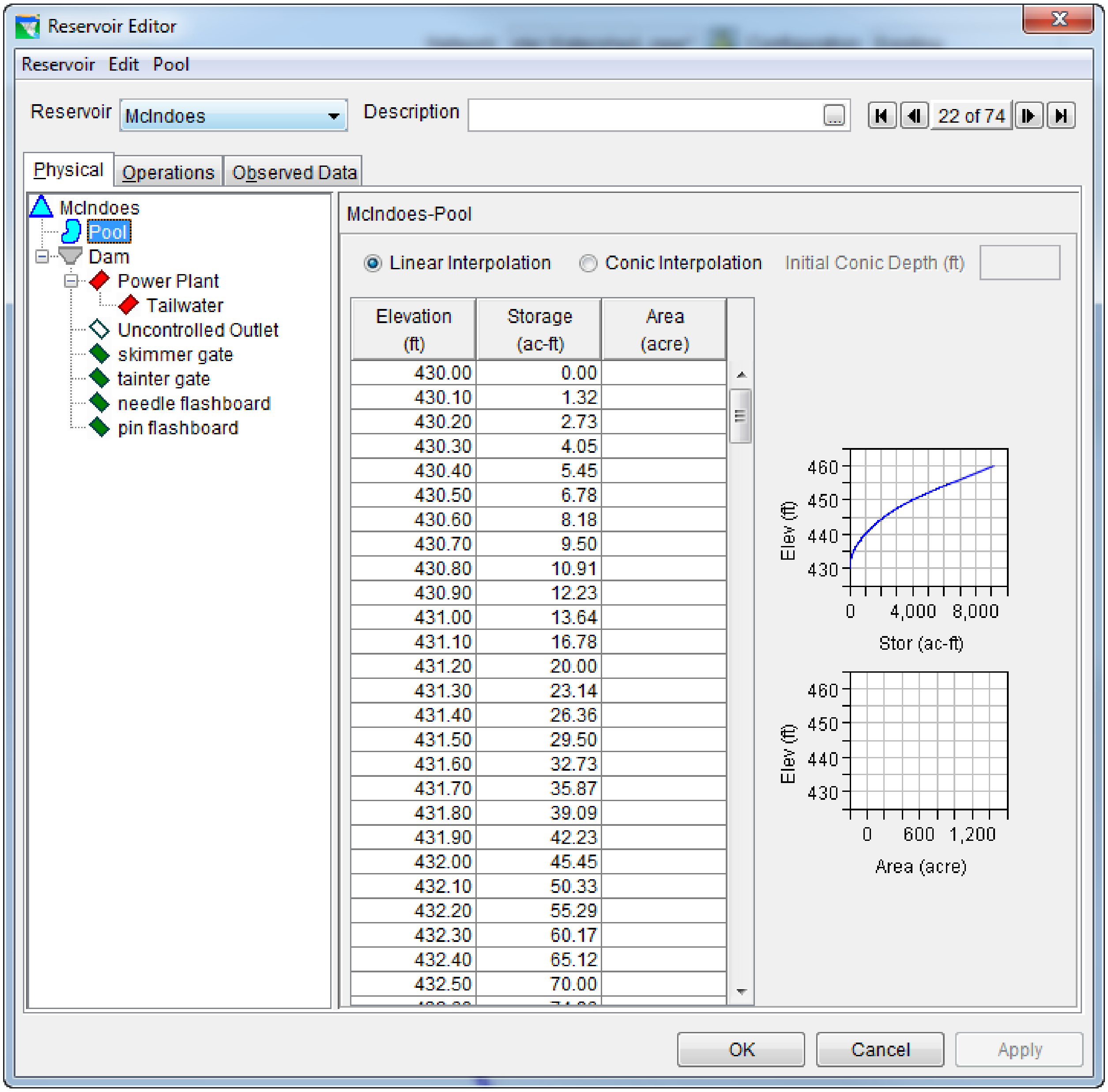


Figure 3: Reservoir Editor: Physical Tab -- Pool

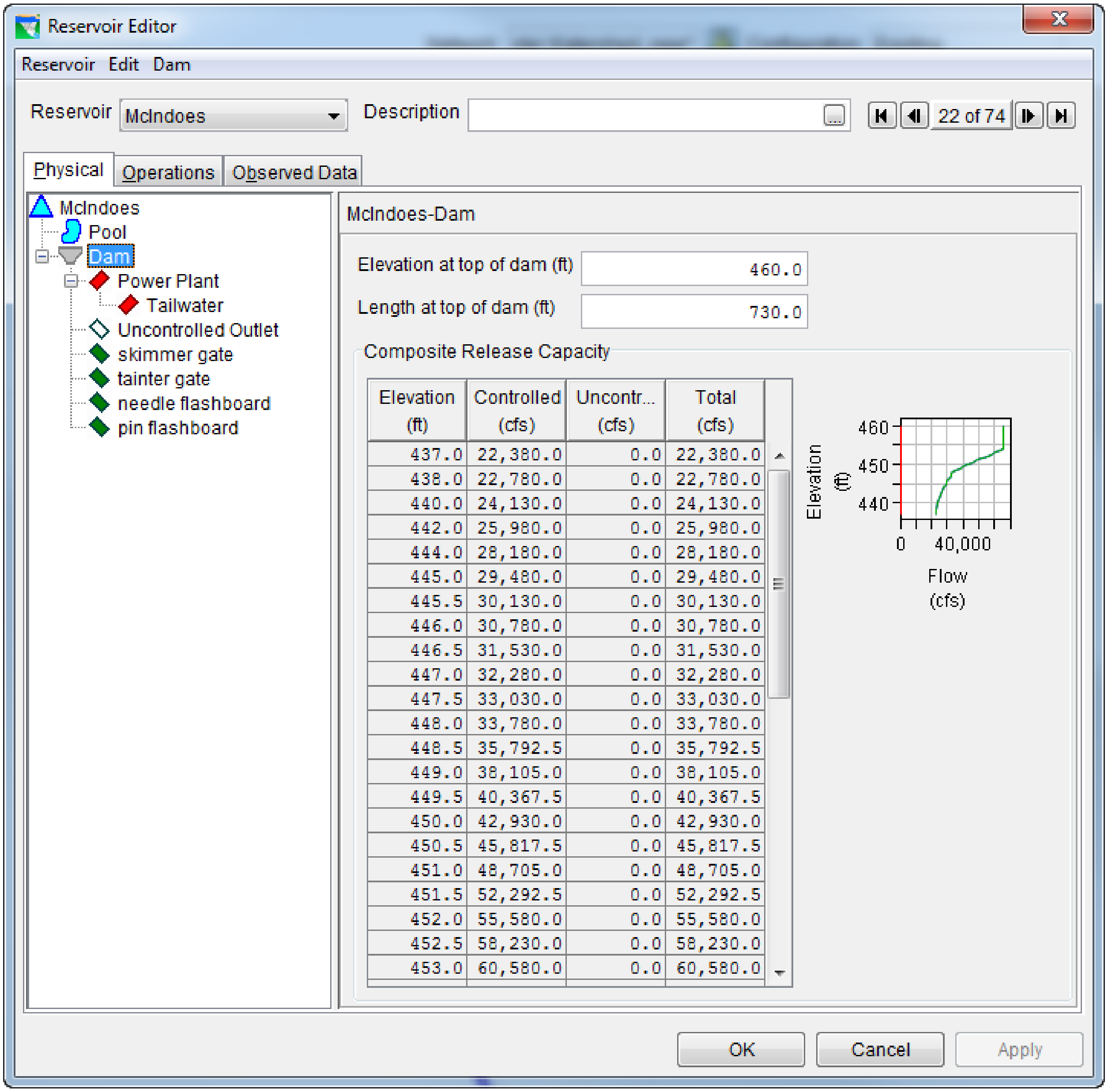


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 4 shows the definition of McIndoes's "Existing" operational zones, which consist of zones of Top of dam (460 ft), Below Top of dam (459 ft), Conservation (451 ft), Bottom of Conservation (447.5 ft), and Inactive zone (436 ft)[1].

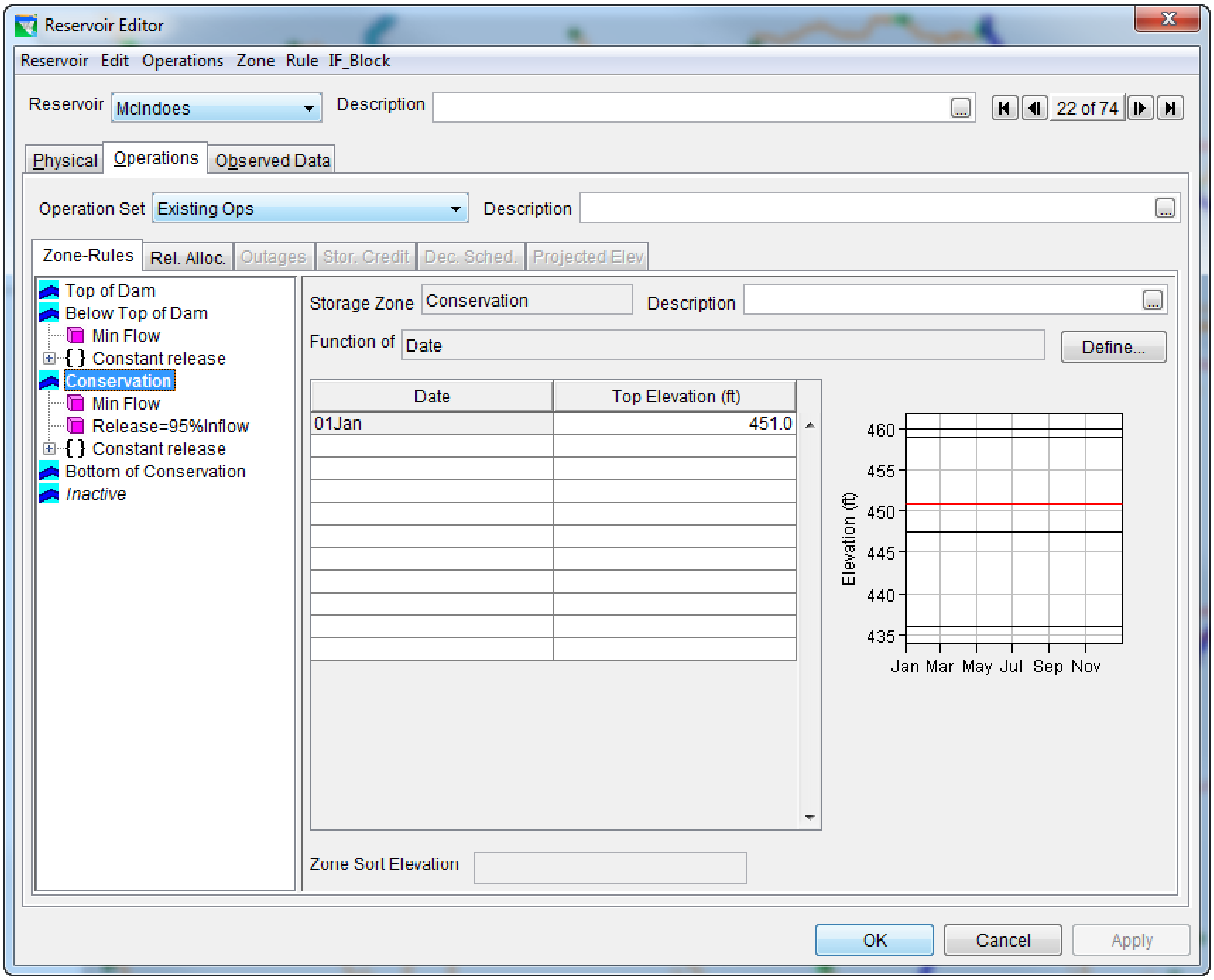


Figure 5: Reservoir Editor: Operations Tab –Existing OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing[65].

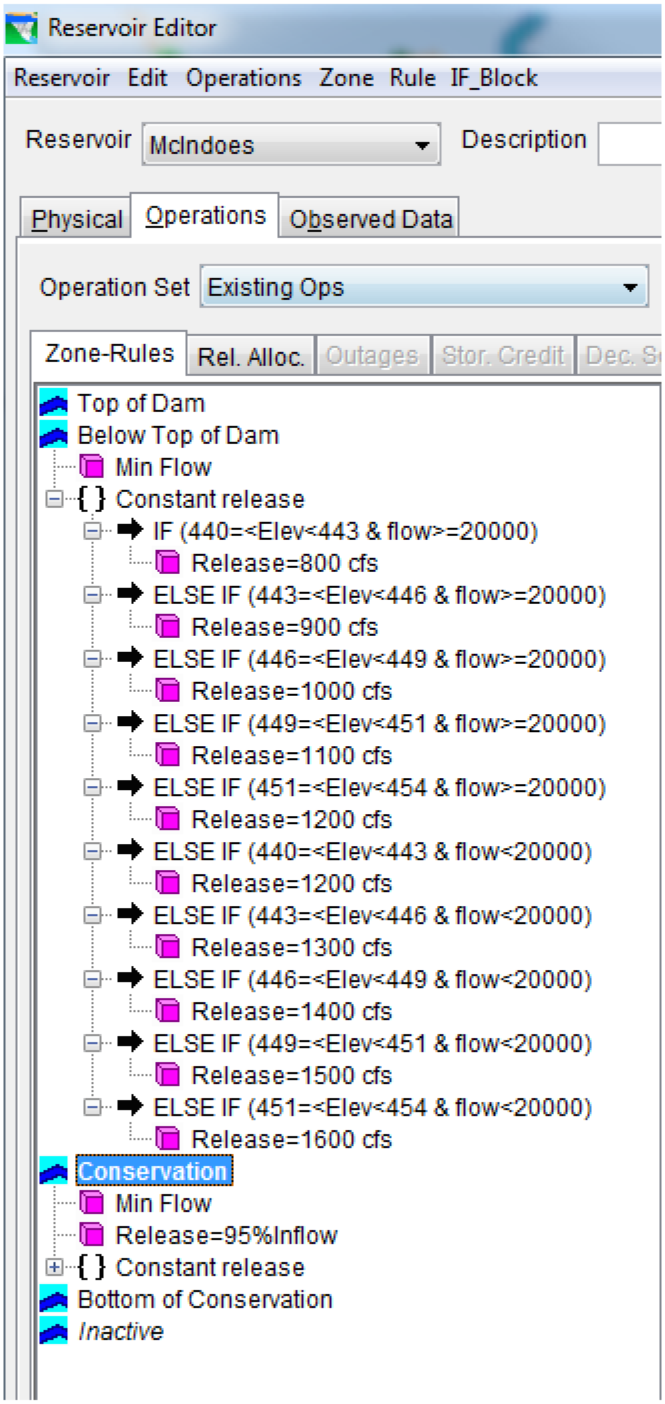


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[65] TransCanada. Connecticut River Operational Constraints. 2012.

Figure 7 shows a sequential release allocation approach specified for available outlets along Bellows Falls Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The skimmer gate gets the remainder of the release until it reaches capacity. Then the flow passes through tainter gate. After the capacity through the tainter gate is reached, the remainder of the release goes through the needle flashboard and pin flashboard, respectively.

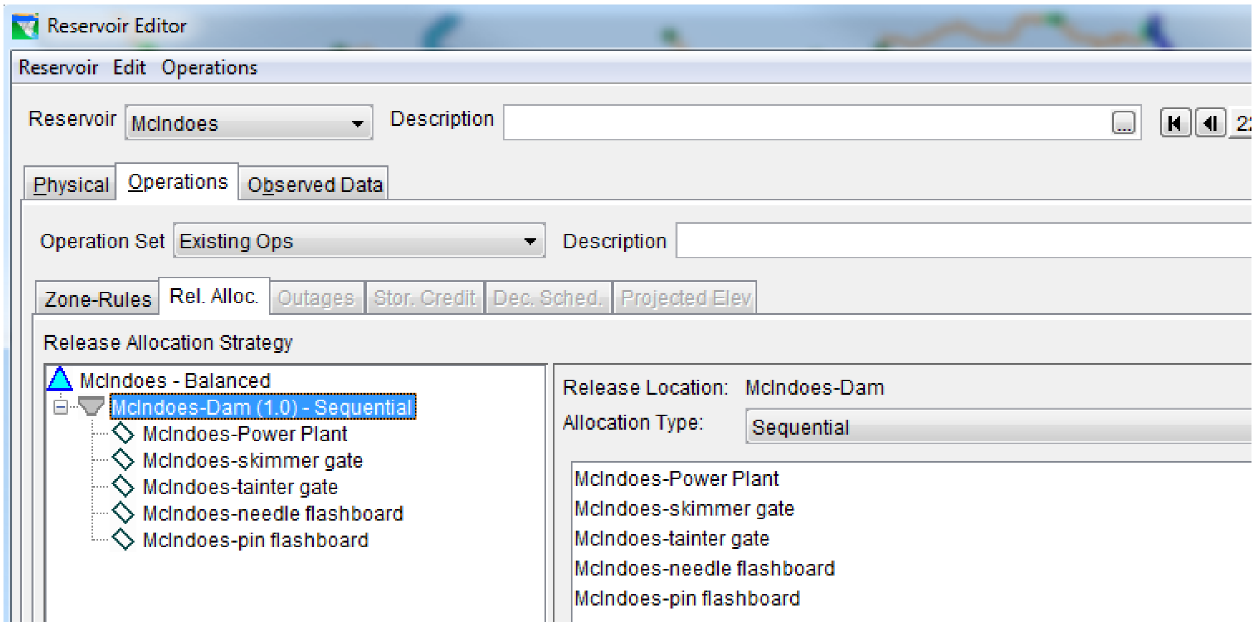


Figure 7: Reservoir Editor: Operations Tab – Existing OpSet – Release Allocation

C. Rule Descriptions

1. Min Flow

Figure 8 shows the content of "Min Flow" rule. This rule represents the minimum allowable release from dam.

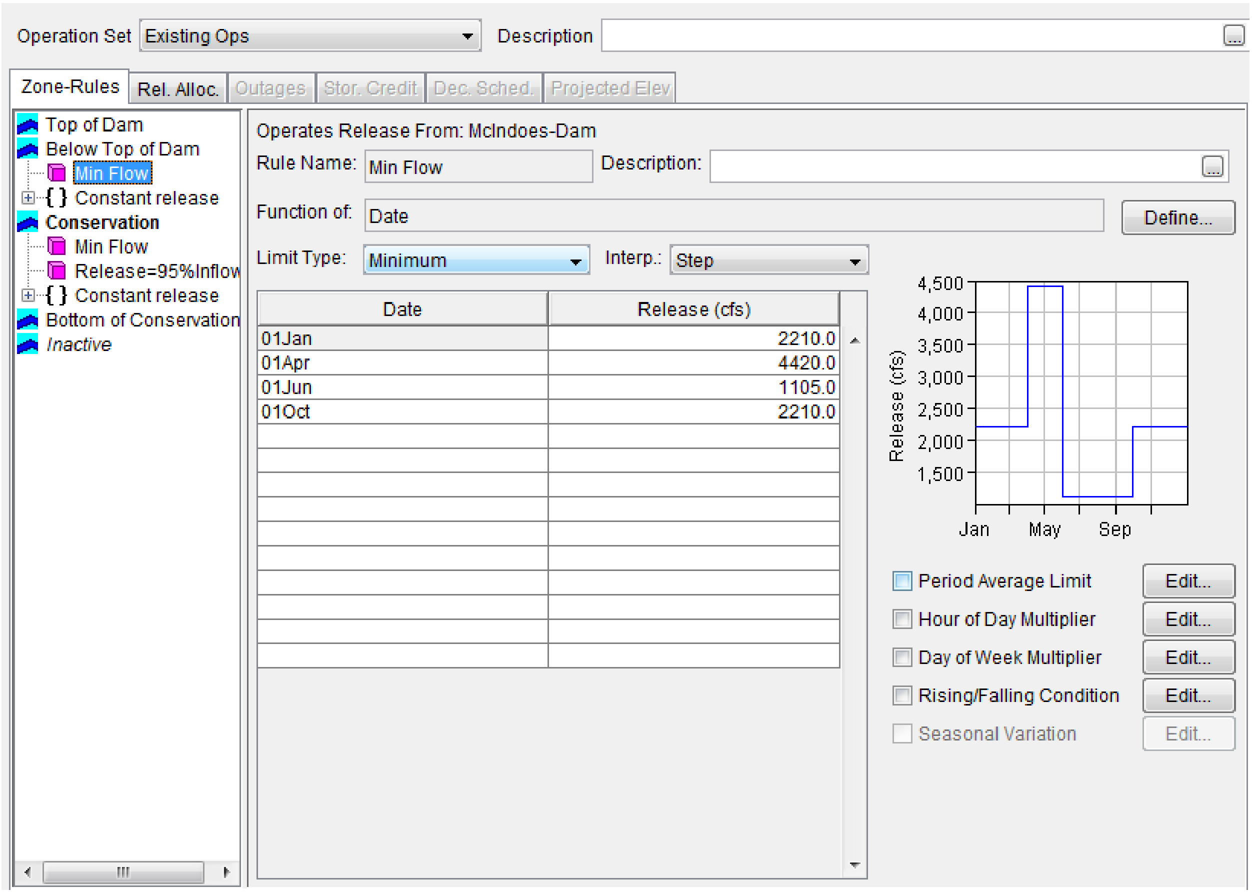


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow

2. Constant release

Figure 9 shows the content of "Constant release" rule. It shows the minimum allowable release for different combinations of Inflow and elevation.

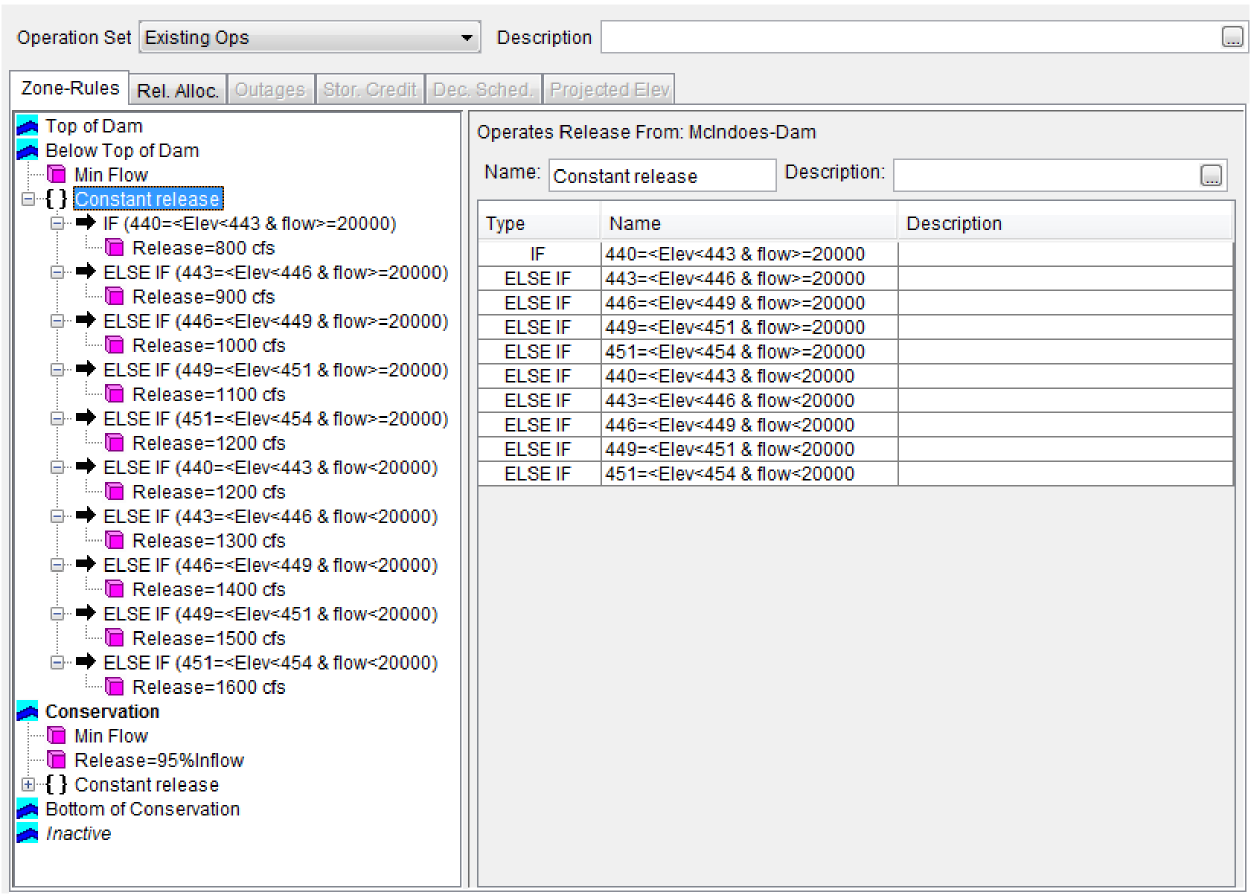


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Constant release

3. *Release=95% Inflow*

Figure 10 shows the content of "Release=95% Inflow" rule. It releases 95% of Inflow as a minimum release from power plant as per the run-of-river modeling strategy.

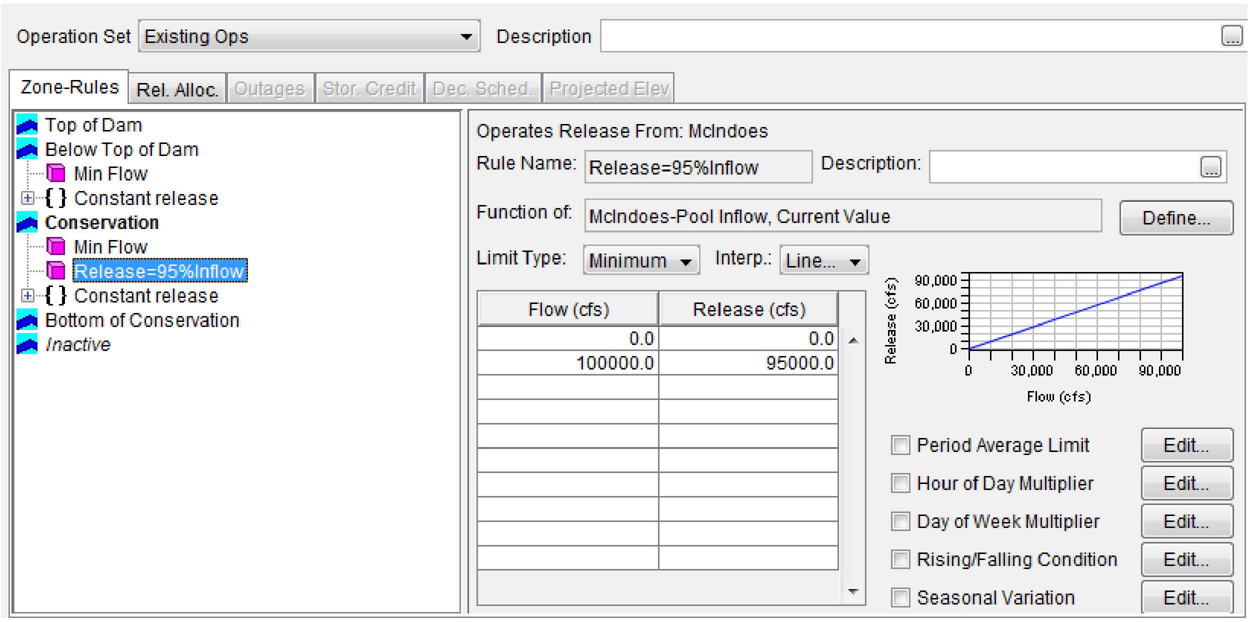


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release=95% Inflow

Moodus

I. Overview

Moodus reservoir and dam is located on the Moodus River in East Haddam, CT. The dam is owned by the State of Connecticut. It is primarily used for recreation and some local flood protection.

Figure 1 shows the location of Moodus reservoir as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Moodus reservoir.

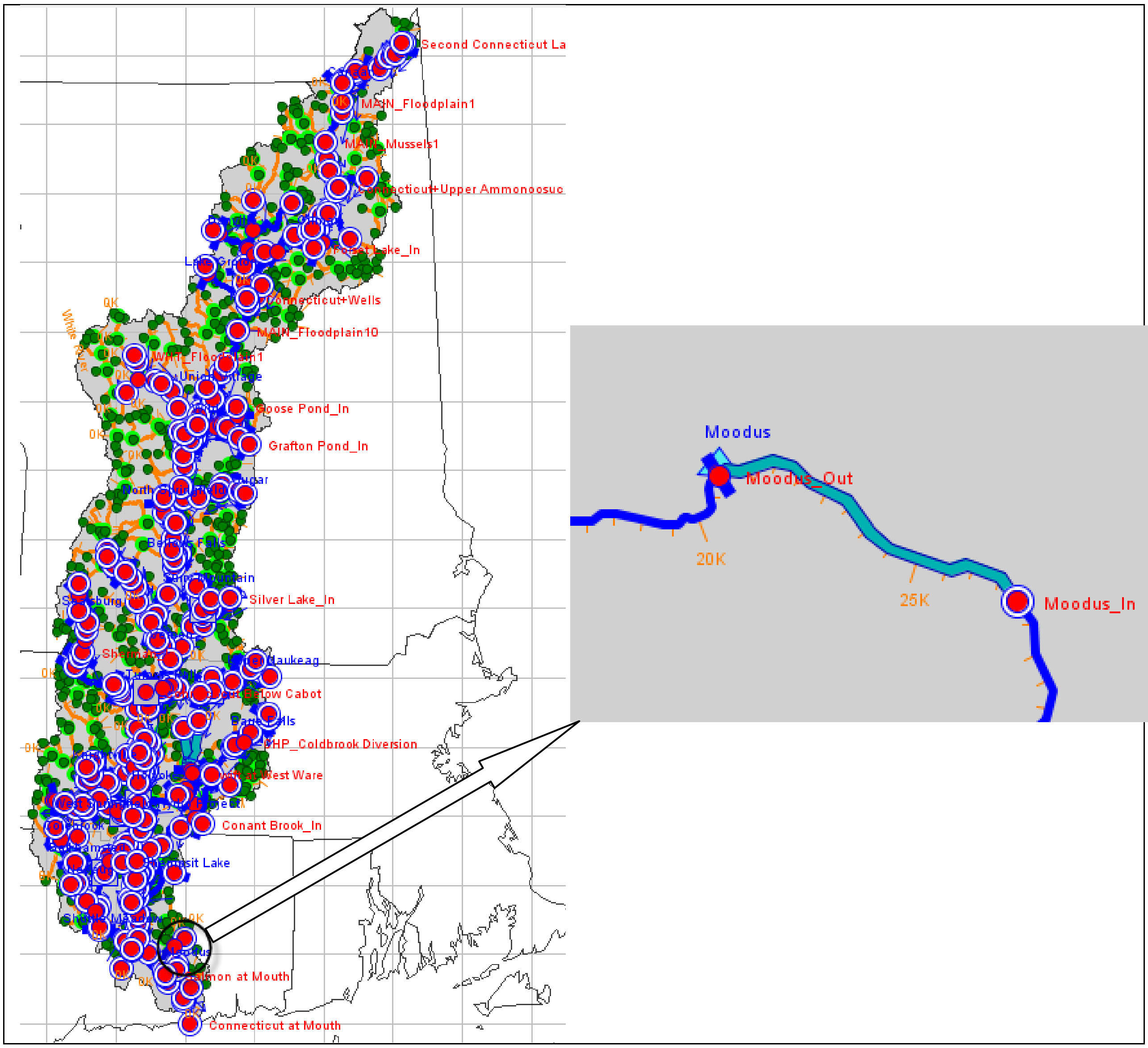


Figure 1: HEC-ResSim Map Display Showing Location of Moodus

Figure 2: Photo of Moodus reservoir

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[66]. The dam consists of an uncontrolled spillway and outlet as shown in Figure 4[67].

[66] Provided by the operators of Moodus
[67] WMC Consulting Engineers. Moodus Reservoir Dam. Newington, CT 2006.

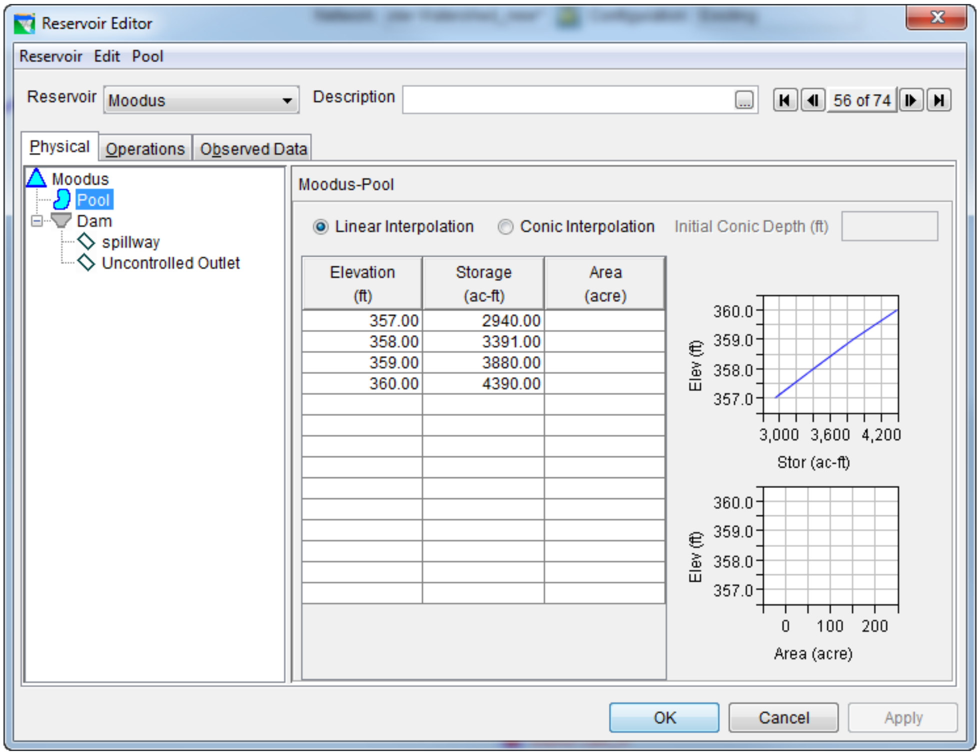


Figure 3: Reservoir Editor: Physical Tab -- Pool

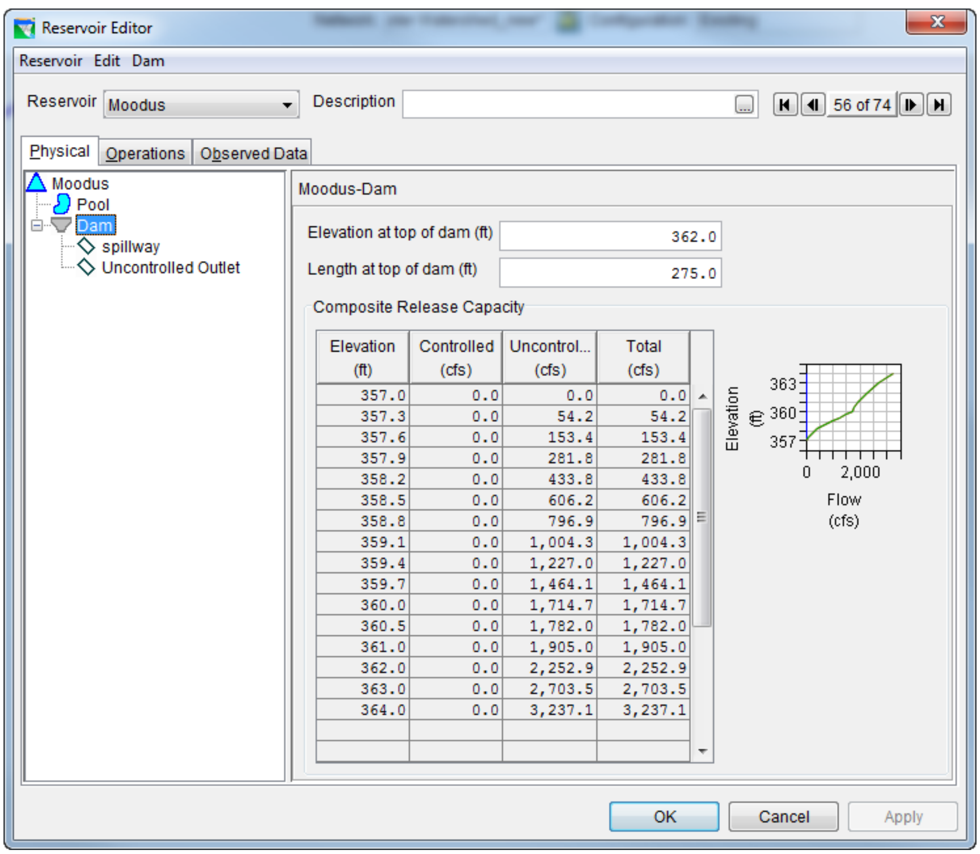


Figure 3 Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 4 shows the definition of Moodus's "Guide Curve" operational zones, which consist of zones of Flood control (360 ft), Conservation (357 ft), and Inactive zone (342.5 ft).

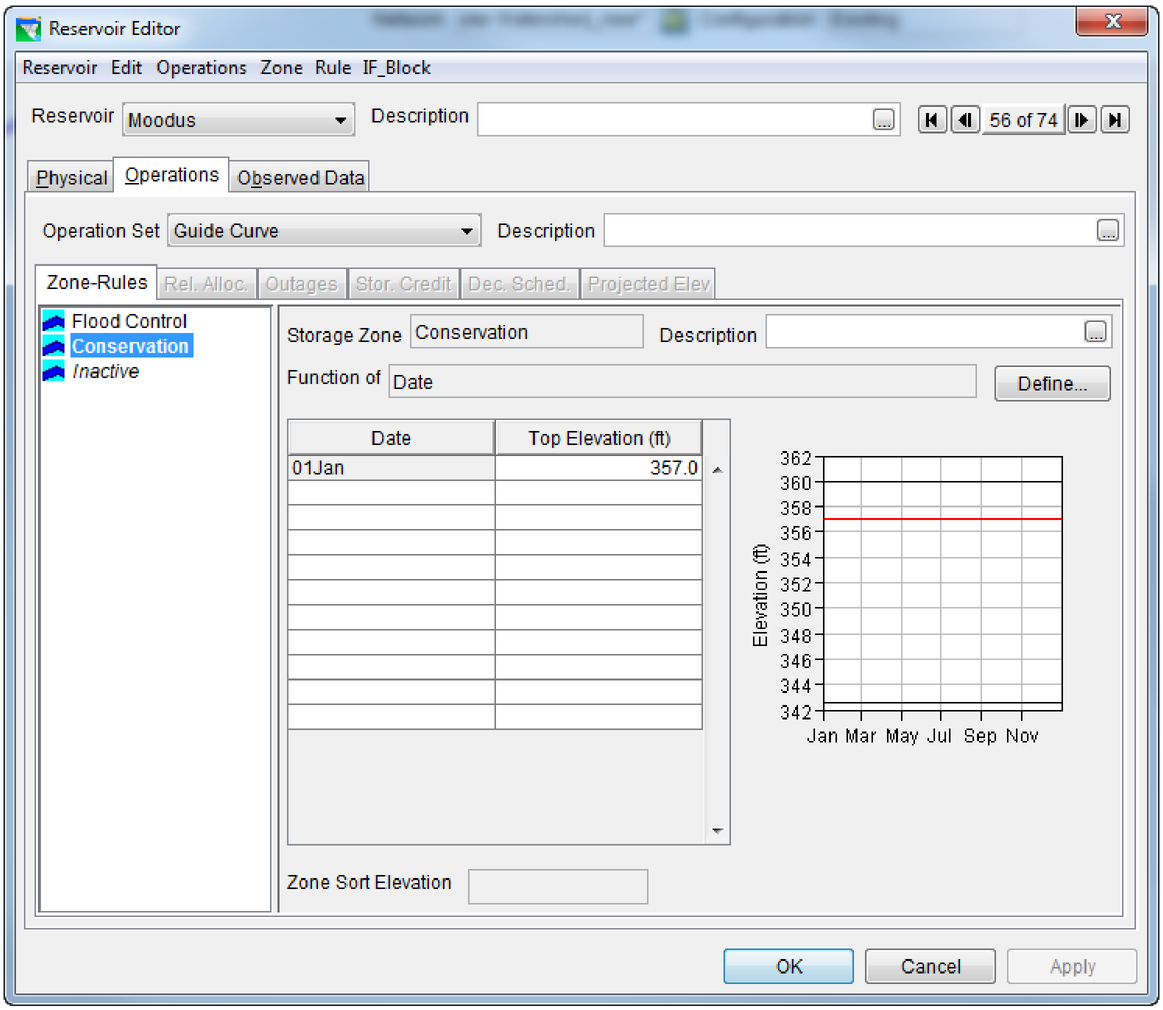


Figure 4 Reservoir Editor: Operations Tab – Guide Curve OpSet

B. Rule Illustrations

The operation set for Moodus has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Moore

I. Overview

Moore dam is located on the mainstem Connecticut River in the towns of Littleton, NH, and Waterford, VT. It is owned and operated by TransCanada Hydro Northeast Inc. as part of the 15 Mile Falls project for hydropower generation on a peaking, seasonal storage basis.

Figure 1 shows the location of Moore dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from Moore dam.

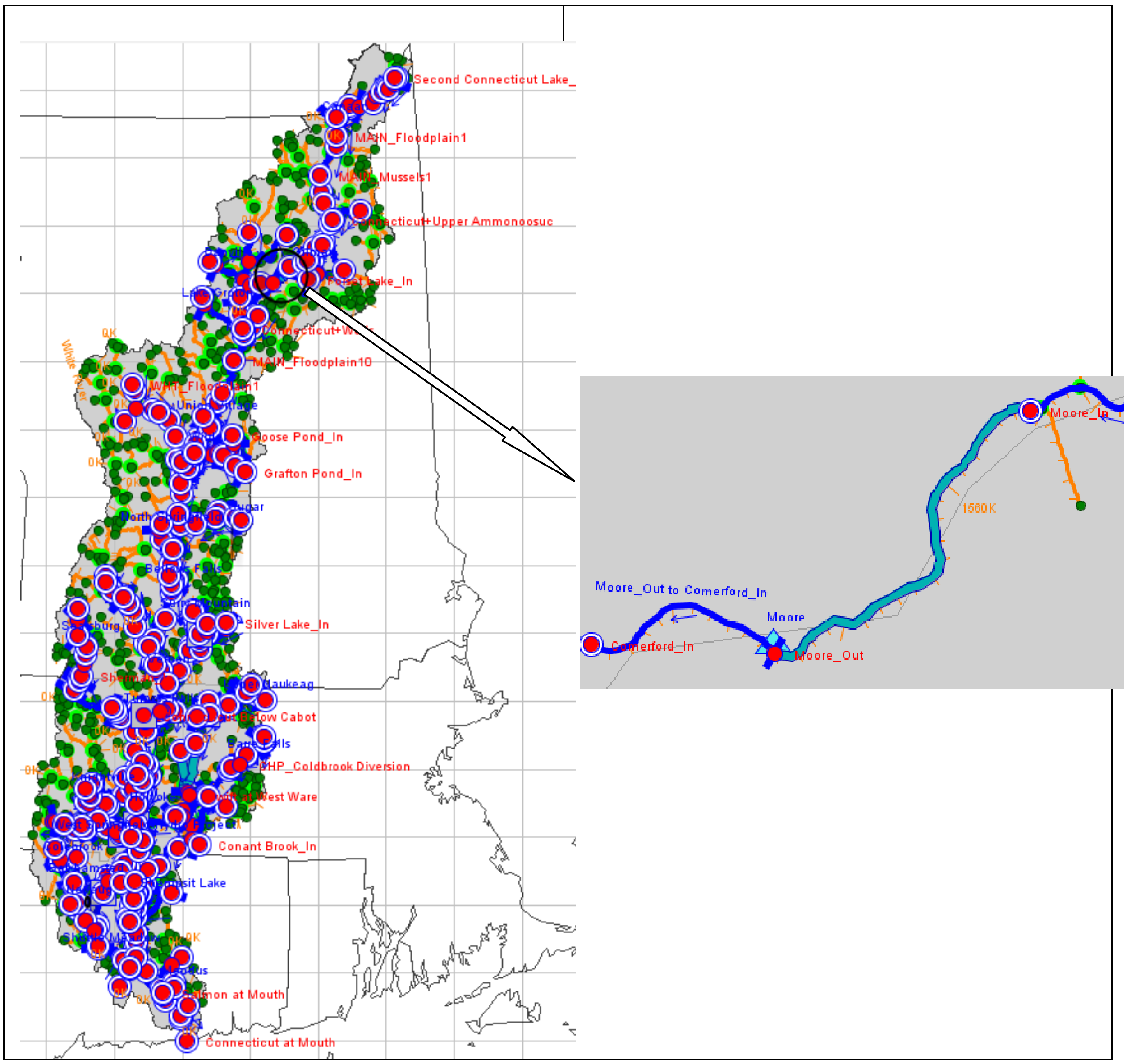


Figure 1 HEC-ResSim Map Display Showing Location of Moore

Figure 2: Photo of Moore dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[68]. The dam consists of four types of outlets: (1) controlled skimmer gate, (2) controlled tainter gate, (3) uncontrolled stanchion Bays, and (4) power plant as shown in Figure 4.

[68] Data provided by TransCanada

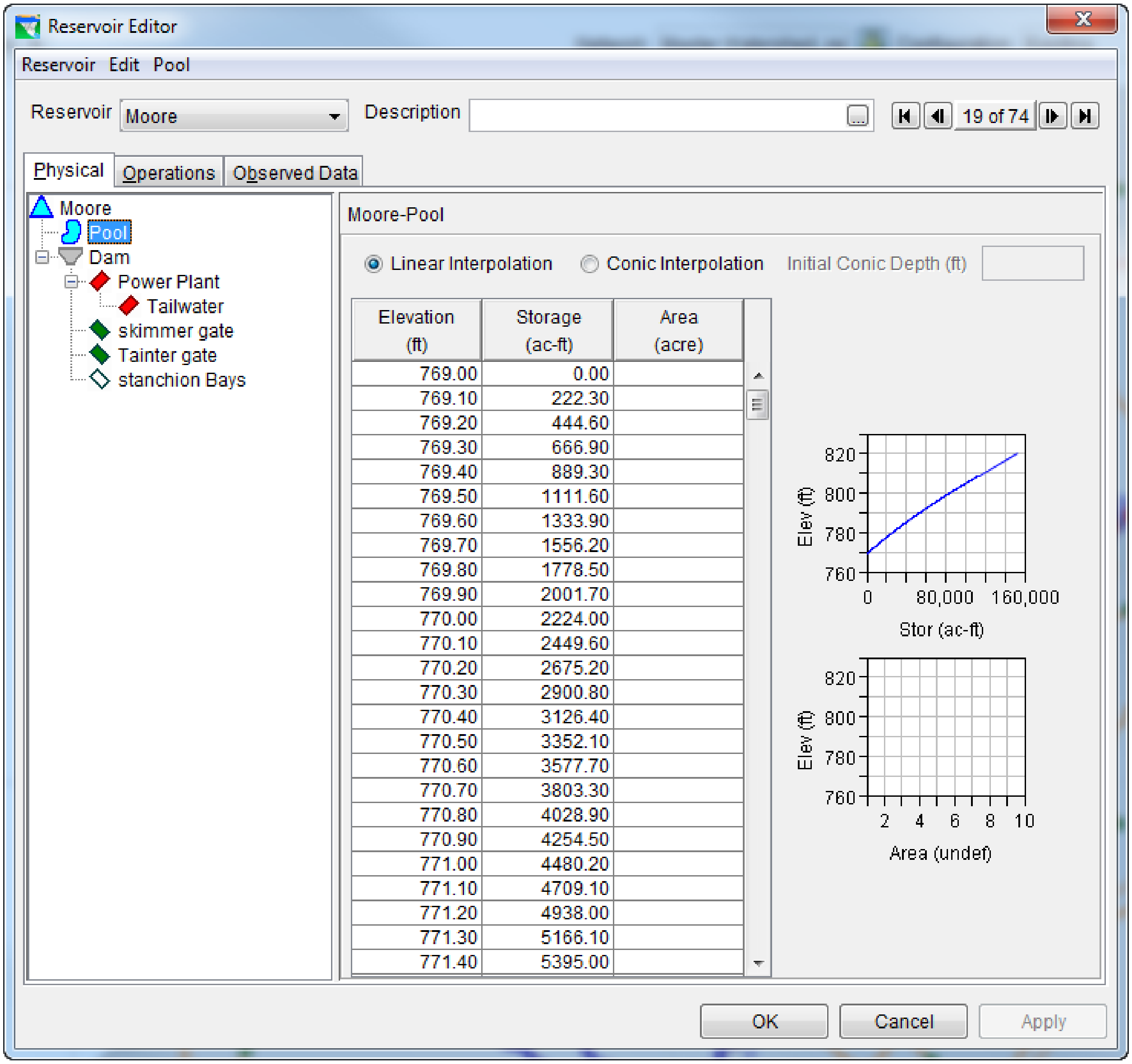
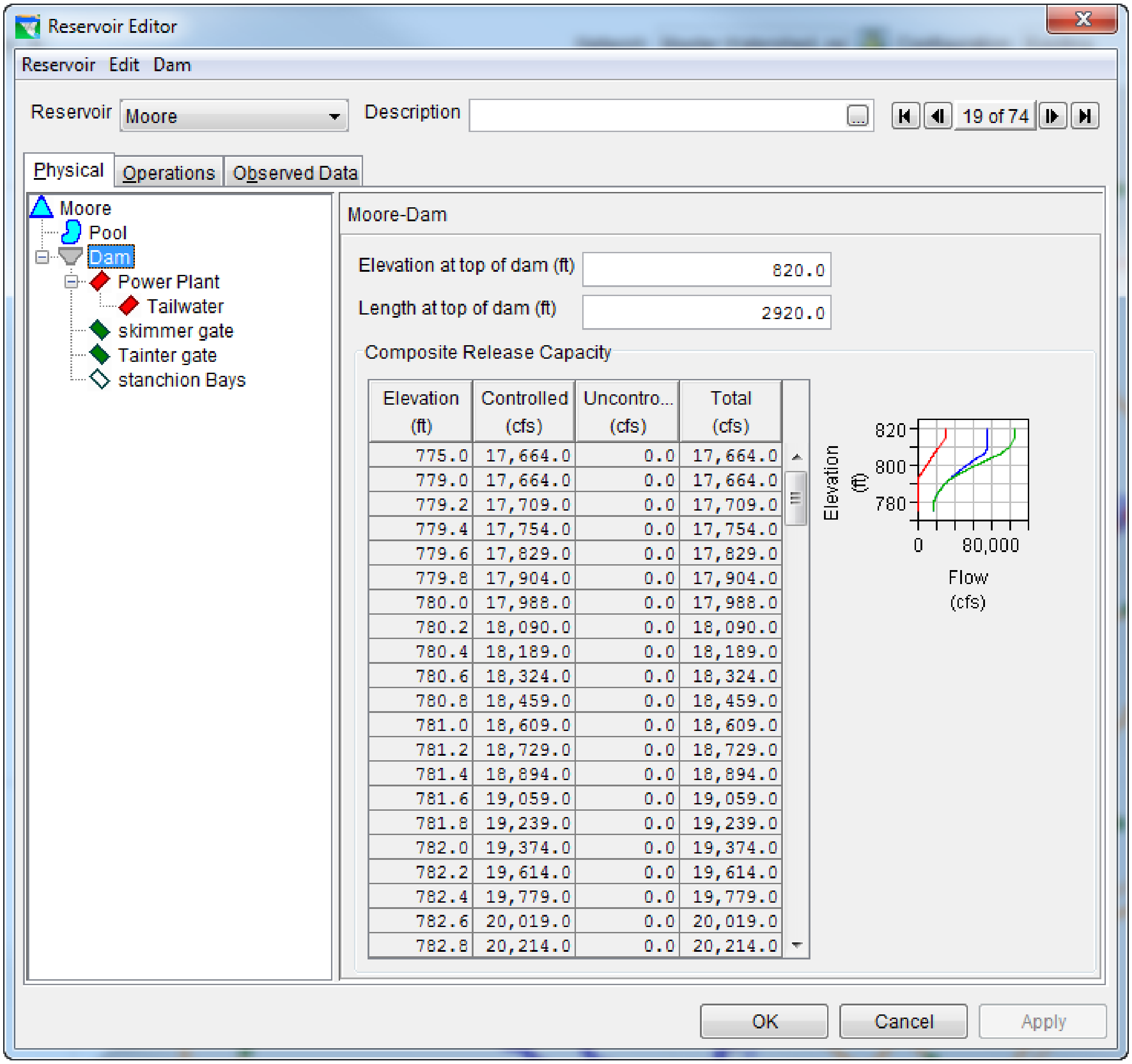


Figure 3: Reservoir Editor: Physical Tab -- Pool



Elevation (ft)	Controlled (cfs)	Uncontro... (cfs)	Total (cfs)
775.0	17,664.0	0.0	17,664.0
779.0	17,664.0	0.0	17,664.0
779.2	17,709.0	0.0	17,709.0
779.4	17,754.0	0.0	17,754.0
779.6	17,829.0	0.0	17,829.0
779.8	17,904.0	0.0	17,904.0
780.0	17,988.0	0.0	17,988.0
780.2	18,090.0	0.0	18,090.0
780.4	18,189.0	0.0	18,189.0
780.6	18,324.0	0.0	18,324.0
780.8	18,459.0	0.0	18,459.0
781.0	18,609.0	0.0	18,609.0
781.2	18,729.0	0.0	18,729.0
781.4	18,894.0	0.0	18,894.0
781.6	19,059.0	0.0	19,059.0
781.8	19,239.0	0.0	19,239.0
782.0	19,374.0	0.0	19,374.0
782.2	19,614.0	0.0	19,614.0
782.4	19,779.0	0.0	19,779.0
782.6	20,019.0	0.0	20,019.0
782.8	20,214.0	0.0	20,214.0

Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Moor's "Existing" operational zones, which consist of zones of Top of dam (820 ft), Below Top of Dam (809 ft), Conservation (779.8-806.5 ft), and Inactive zone (769 ft). The Conservation Pool Elevation curve was created from 10 years of weekly average pool elevation[1].

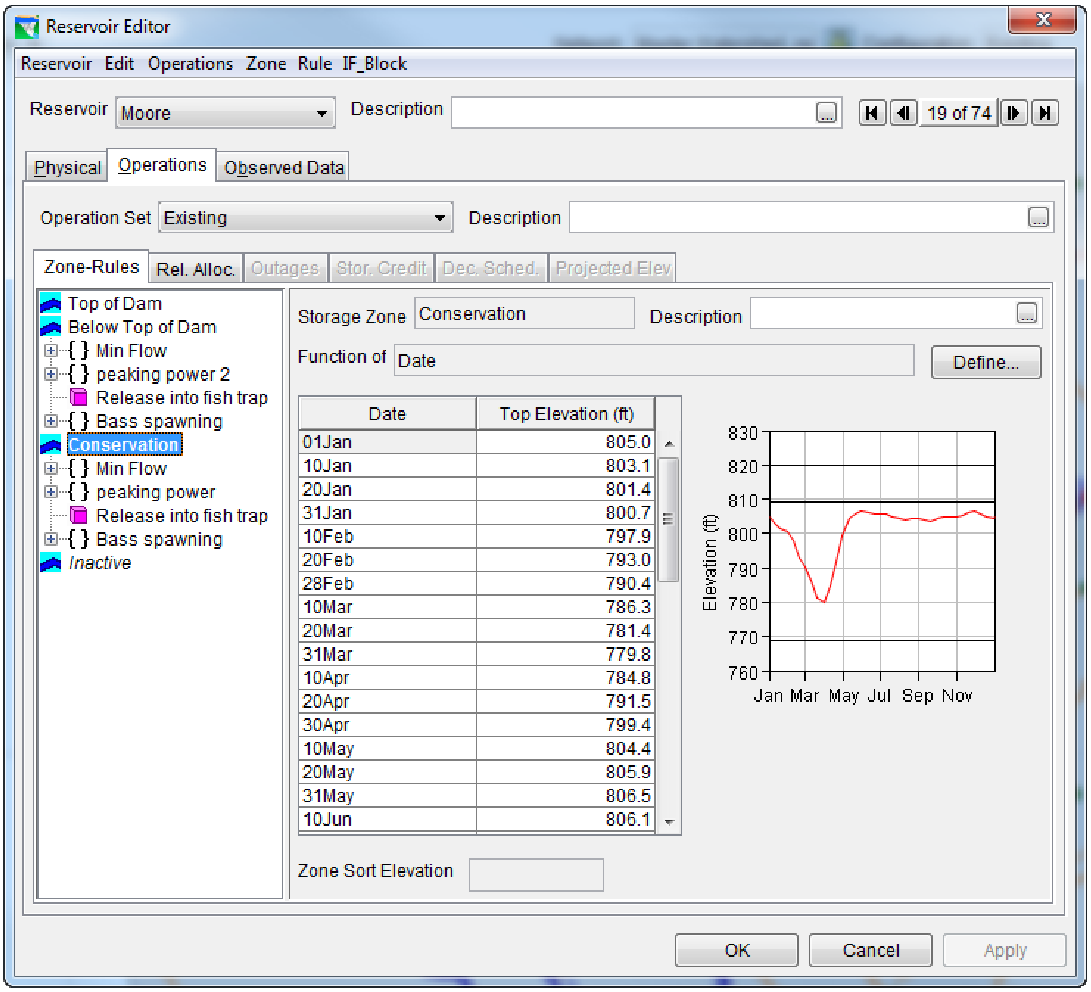


Figure 5: Reservoir Editor: Operations Tab –Existing OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Harriman Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The skimmer gate and tainter gate gets the remainder of the release, respectively.

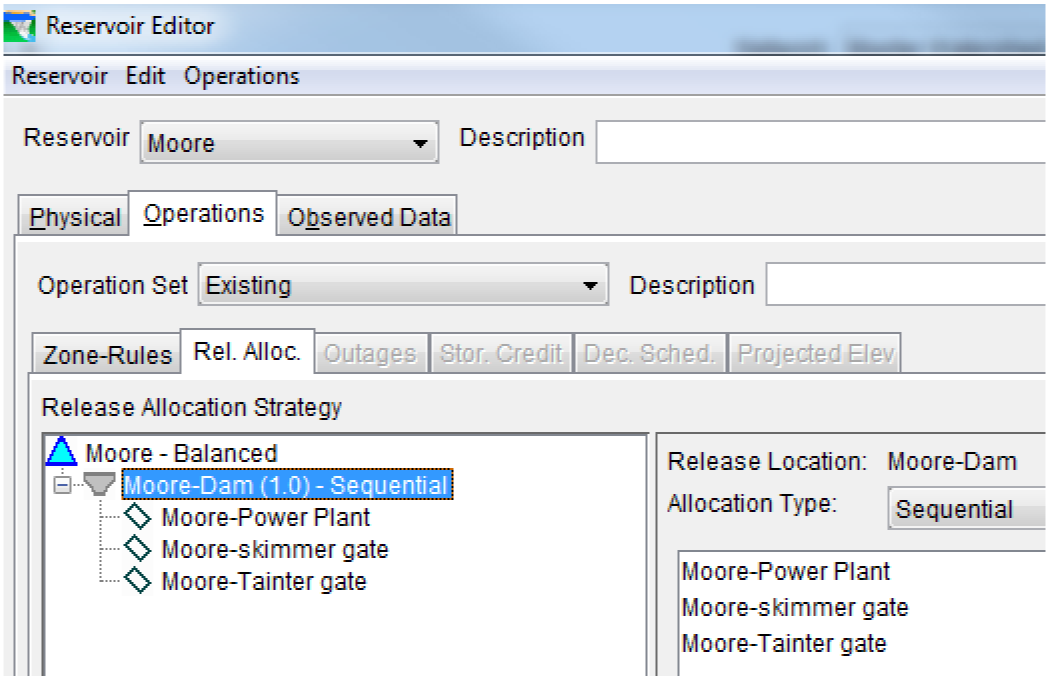


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing[69].

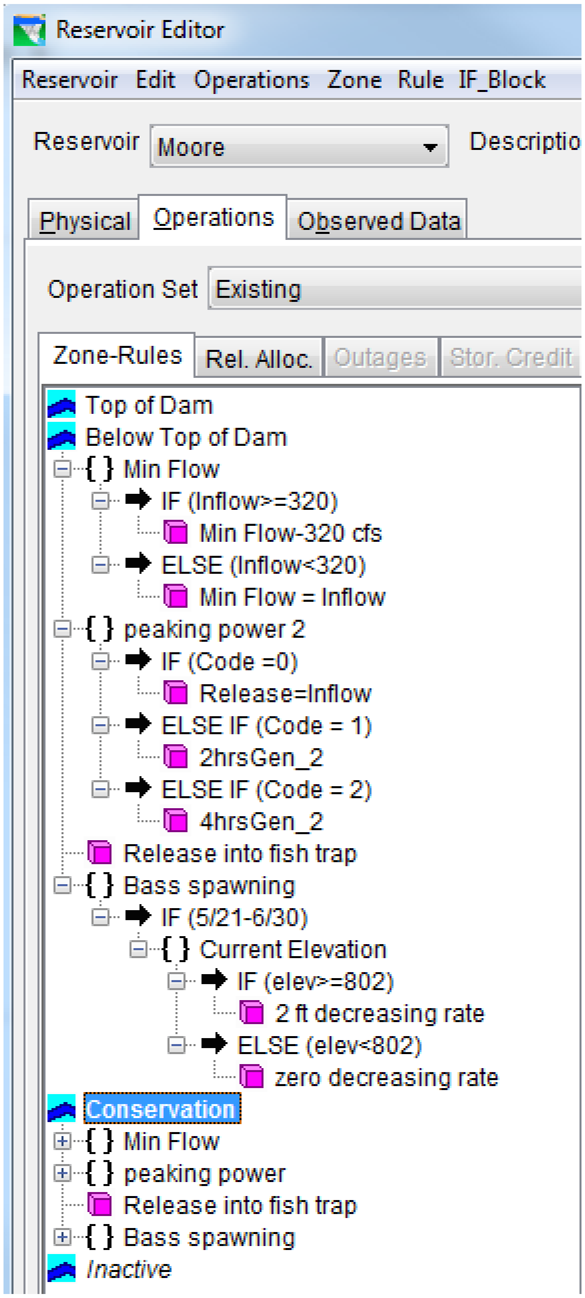


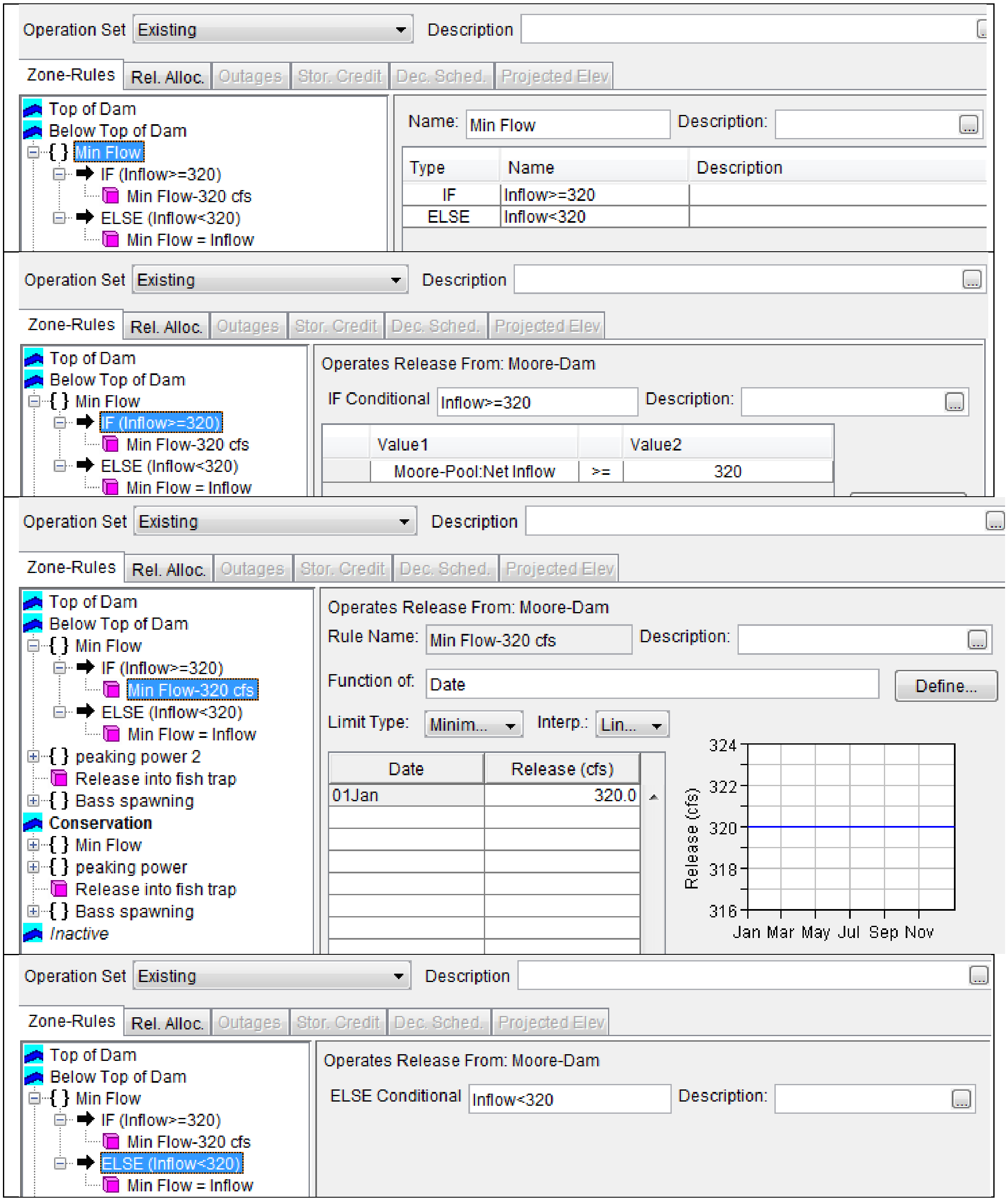
Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[69] TransCanada. Connecticut River Operational Constraints. 2012.

C. Rule Descriptions

1. Min flow

Figure 8 shows the content of “Min Flow” rule. This rule sets the minimum flow to 320 cfs for the inflows greater than 320 cfs and inflow for the inflows less than 320 cfs.



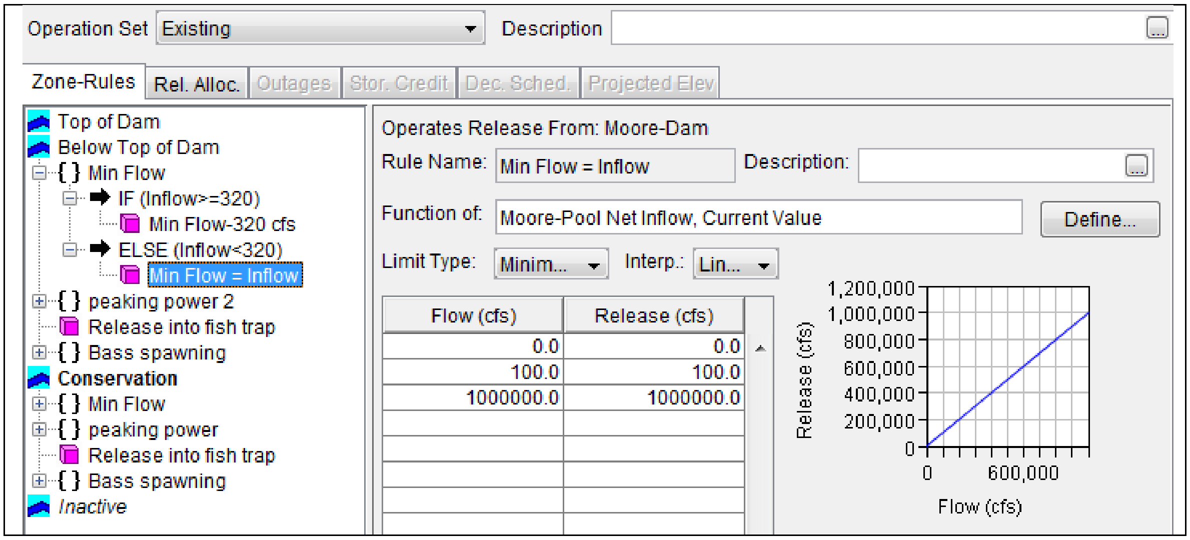
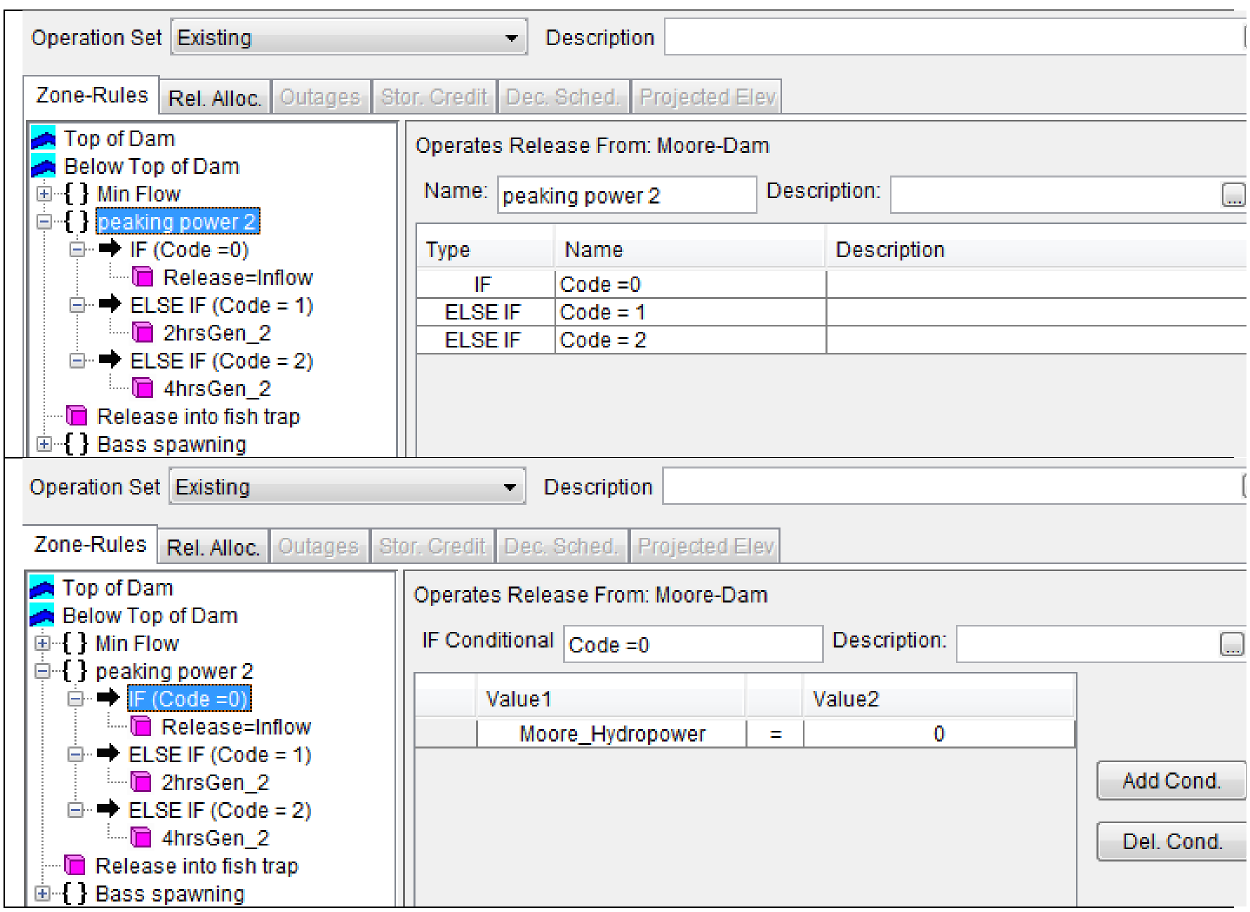
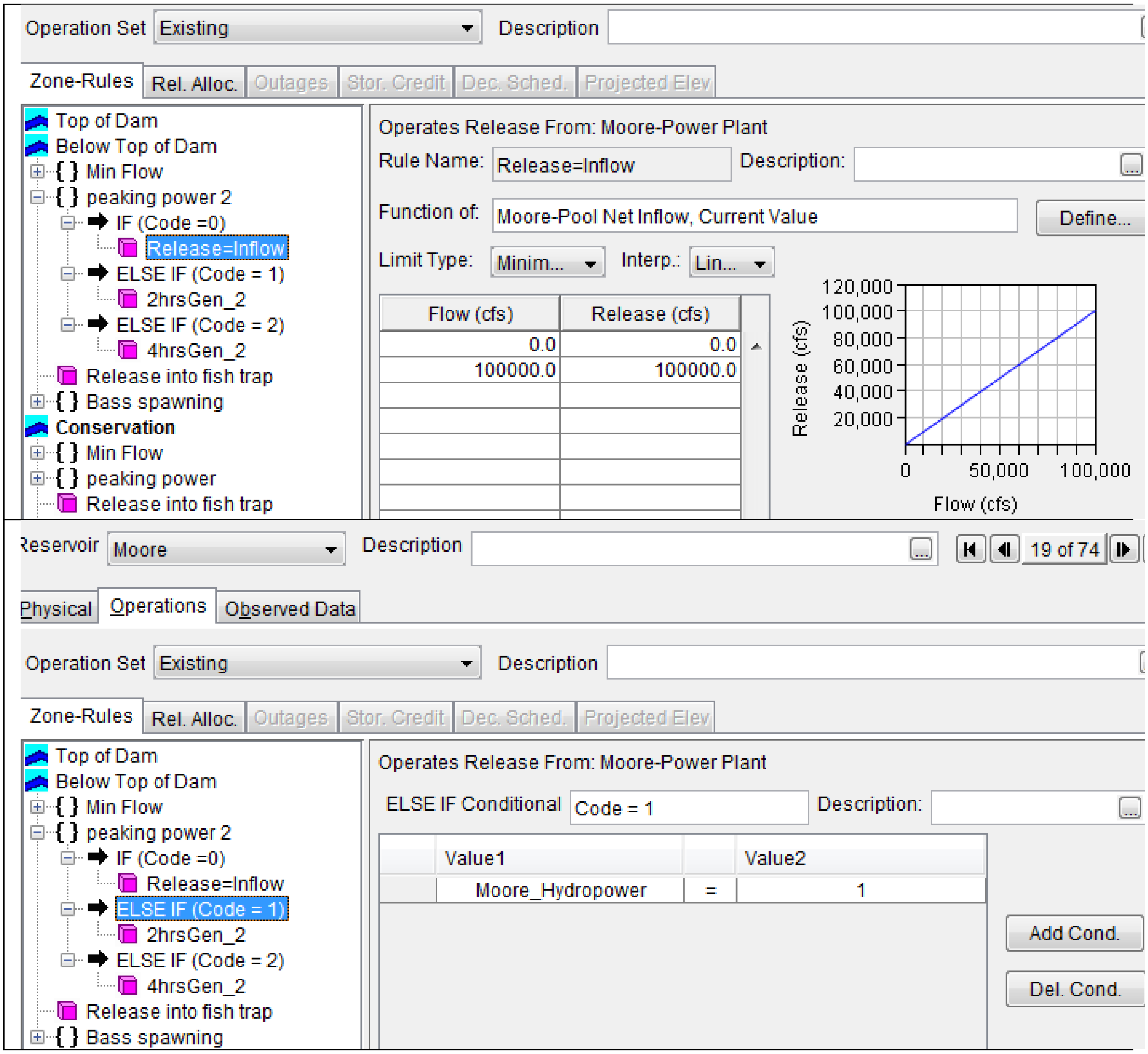


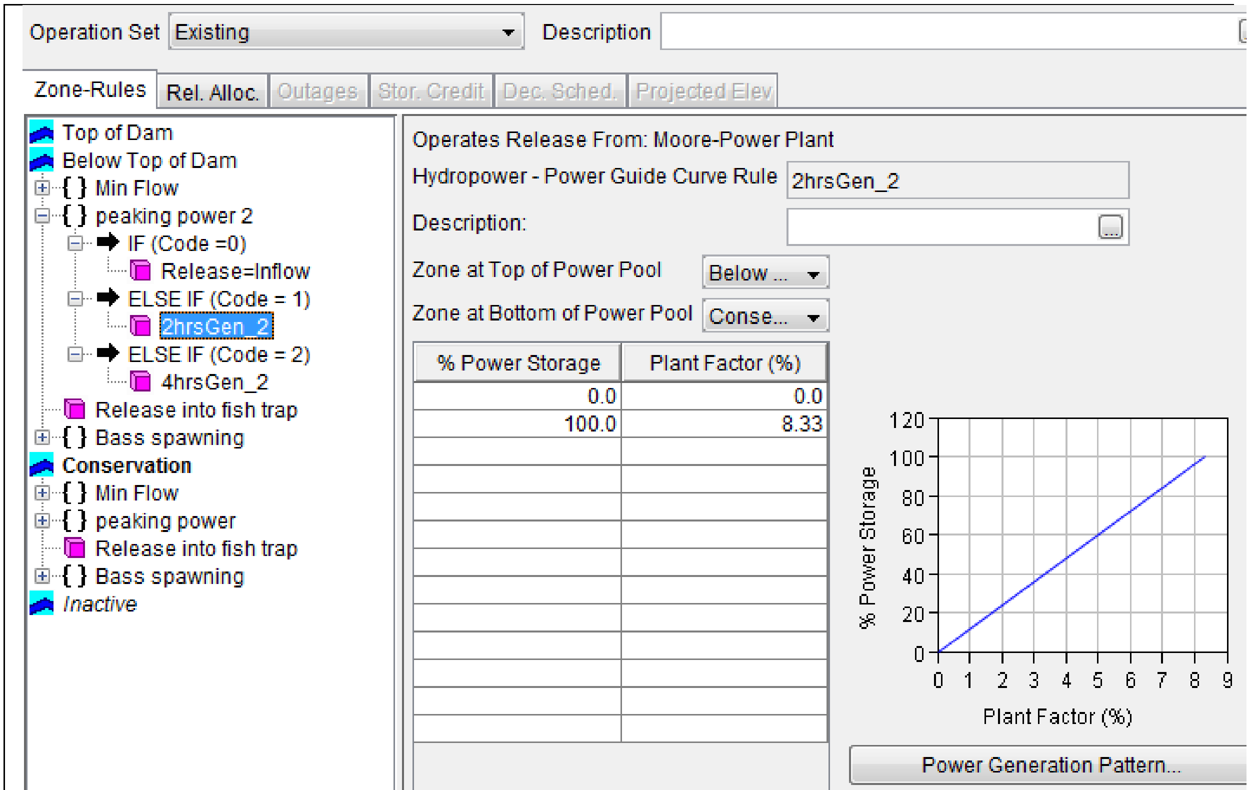
Figure 8: Reservoir Editor: Operations Tab – Existing OpSet – Min Flow

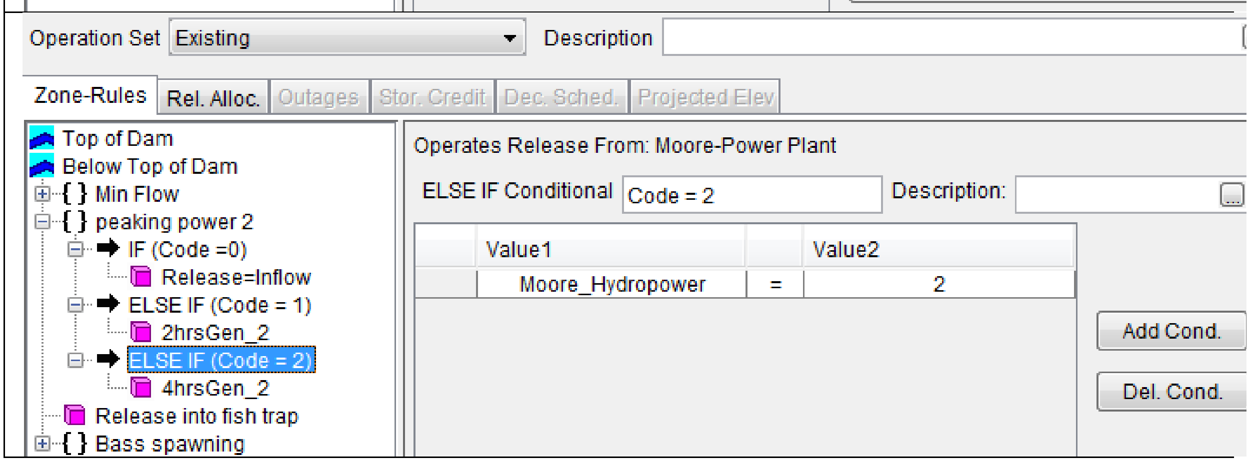
2. Peaking power 2

This rule represents the peaking power strategy applied for Moore reservoir. The content of the rule is shown in Figure 9.




Operation Set
Existing
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of Dam
Below Top of Dam
{ } Min Flow
{ } peaking power 2
IF (Code =0)
Release=Inflow
ELSE IF (Code = 1)
2hrsGen_2
ELSE IF (Code = 2)
4hrsGen_2
Release into fish trap
{ } Bass spawning
Conservation
{ } Min Flow
{ } peaking power
Release into fish trap
Operates Release From: Moore-Power Plant
Rule Name:
Release=Inflow
Description:
Function of:
Moore-Pool Net Inflow, Current Value
Define...
Limit Type:
Minim...
Interp.:
Lin...
Flow (cfs)
Release (cfs)
0.0
0.0
100000.0
100000.0
120,000
100,000
80,000
60,000
40,000
20,000
Release (cfs)
0
50,000
100,000
Flow (cfs)
Reservoir
Moore
Description
19 of 74
Physical
Operations
Observed Data
Operation Set
Existing
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of Dam
Below Top of Dam
{ } Min Flow
{ } peaking power 2
IF (Code =0)
Release=Inflow
ELSE IF (Code = 1)
2hrsGen_2
ELSE IF (Code = 2)
4hrsGen_2
Release into fish trap
{ } Bass spawning
Operates Release From: Moore-Power Plant
ELSE IF Conditional
Code = 1
Description:
Value1
Value2
Moore_Hydropower
=
1
Add Cond.
Del. Cond.


Operation Set
Existing
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of Dam
Below Top of Dam
{ } Min Flow
{ } peaking power 2
IF (Code =0)
Release=Inflow
ELSE IF (Code = 1)
2hrsGen_2
ELSE IF (Code = 2)
4hrsGen_2
Release into fish trap
{ } Bass spawning
Conservation
{ } Min Flow
{ } peaking power
Release into fish trap
{ } Bass spawning
Inactive
Operates Release From: Moore-Power Plant
Hydropower - Power Guide Curve Rule
2hrsGen_2
Description:
Zone at Top of Power Pool
Below ...
Zone at Bottom of Power Pool
Conse...
% Power Storage
Plant Factor (%)
0.0
0.0
100.0
8.33
% Power Storage
Plant Factor (%)
Power Generation Pattern...


Operation Set
Existing
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of Dam
Below Top of Dam
{ } Min Flow
{ } peaking power 2
IF (Code =0)
Release=Inflow
ELSE IF (Code = 1)
2hrsGen_2
ELSE IF (Code = 2)
4hrsGen_2
Release into fish trap
{ } Bass spawning
Operates Release From: Moore-Power Plant
ELSE IF Conditional
Code = 2
Description:
Value1
Value2
Moore_Hydropower
=
2
Add Cond.
Del. Cond.

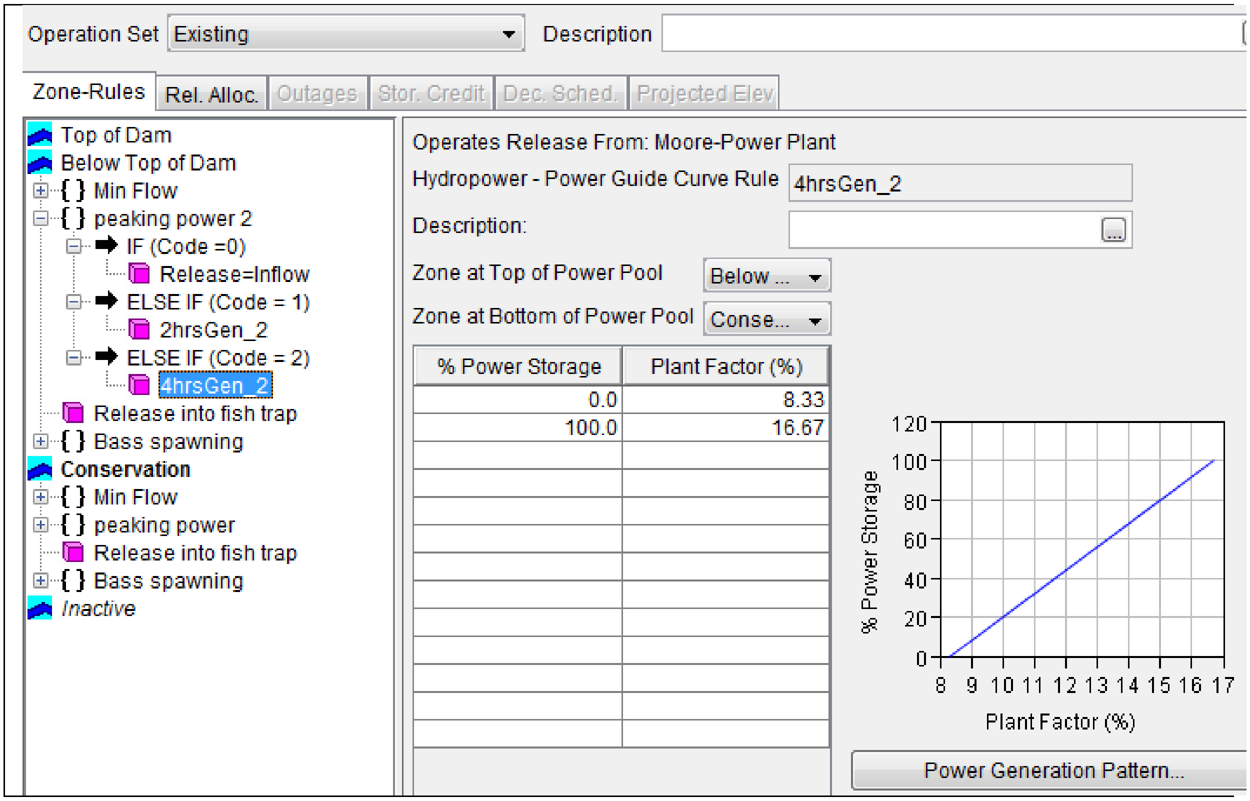


Figure 9: Reservoir Editor: Operations Tab – Existing OpSet –peaking power 2

Figure 10 describes the definition of codes used in the Moore_Volume state variable. The code is summing up the current Inflow and previous storage in each time step, compare it to the volume needed for generating 2 and 4 hours power and to the spillway storage minus inactive storage and then decide how much to release.

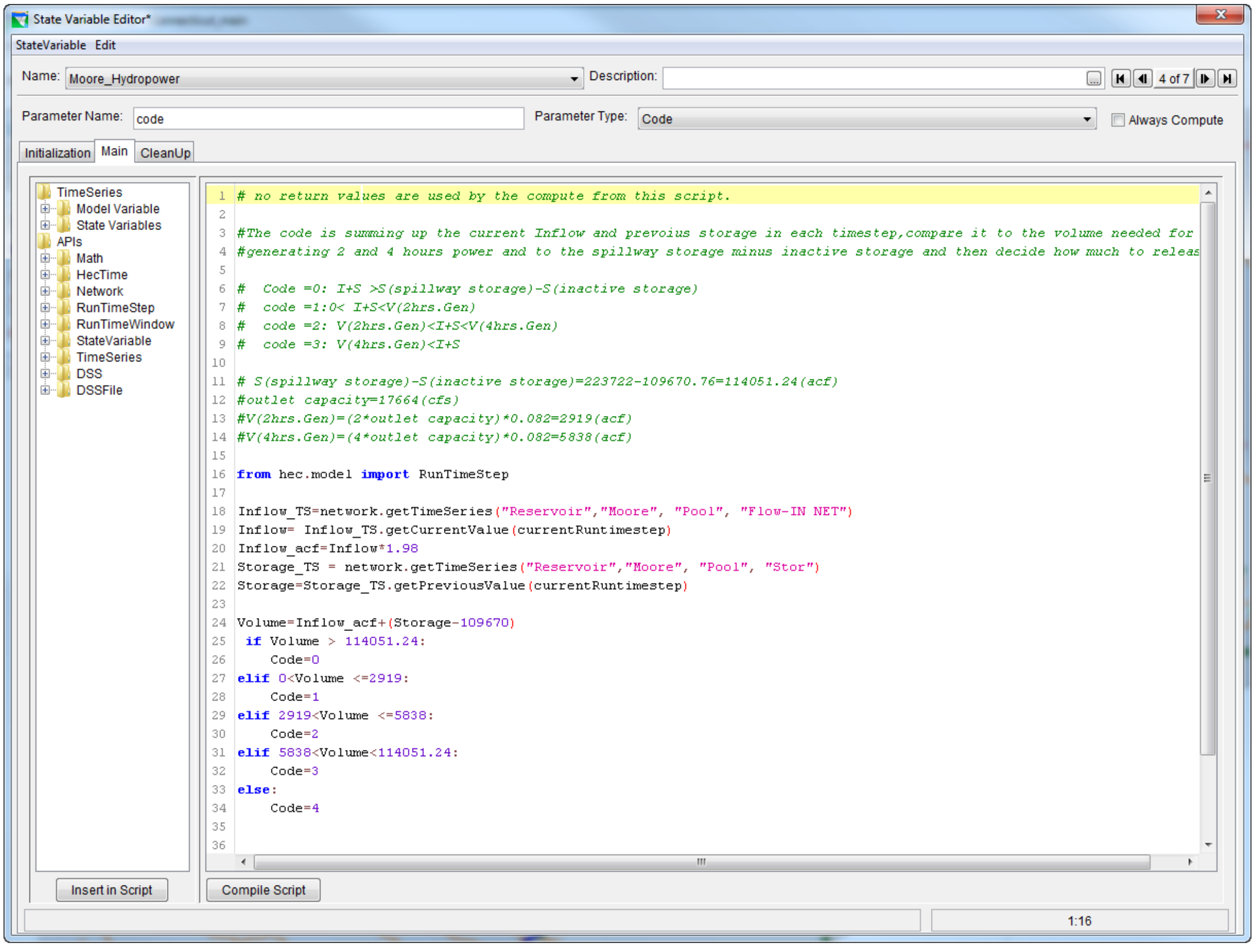


Figure 10: State Variable Editor: Moor_Volume

3. *Release into fish trap*

Figure 11 shows the content of “Release into fish trap” rule. This rule represents a 500 cfs release from Apr1-Jun15.

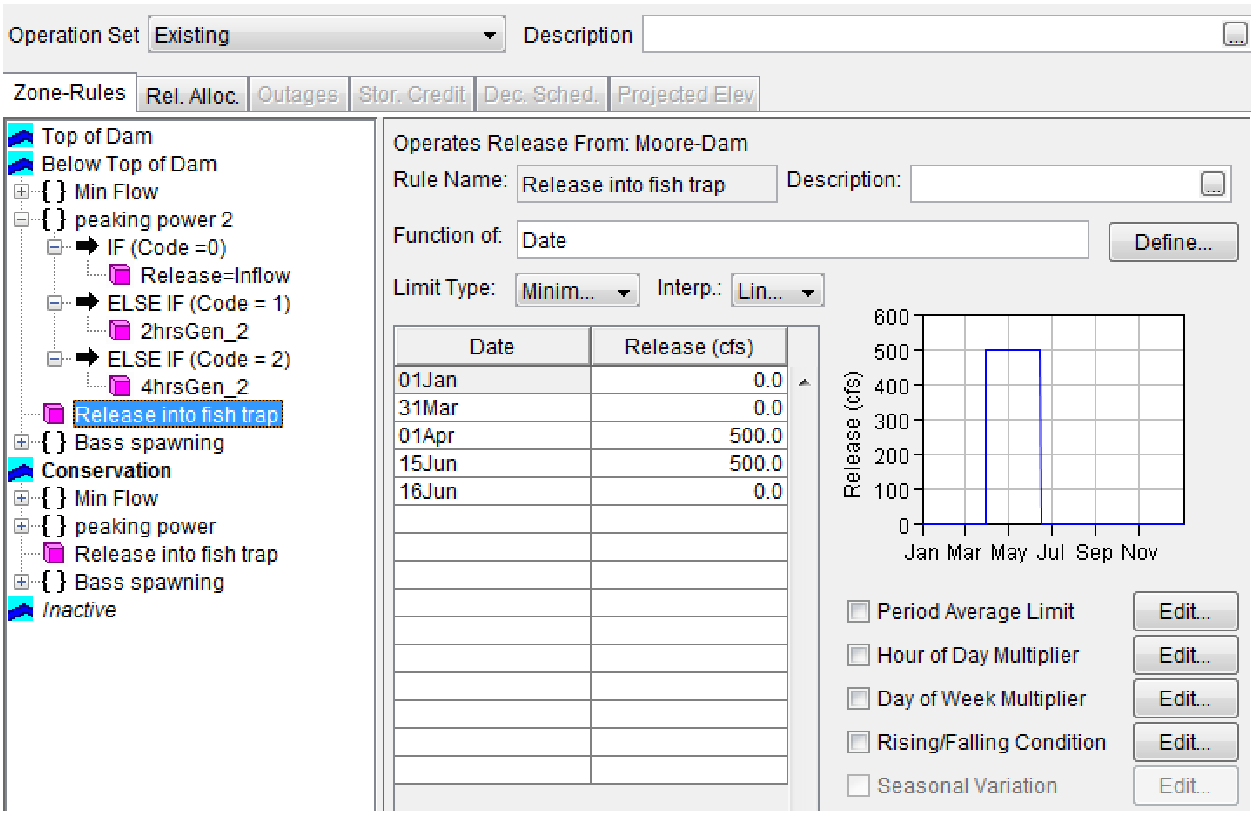
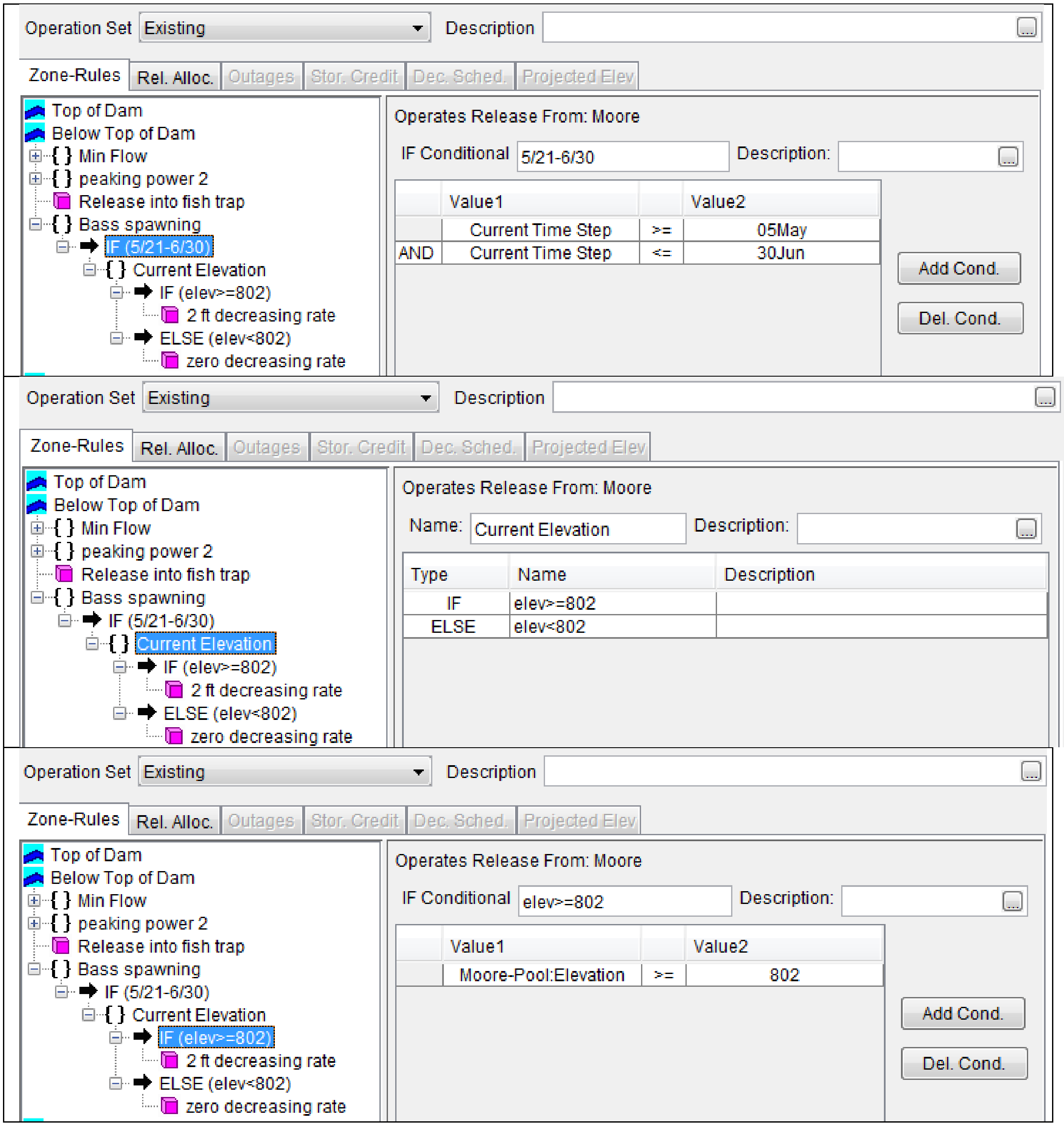


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release into fish trap

4. *Bass spawning*

Figure 12 shows the content of "Bass spawning" rule. It shows a decreasing maximum rate of elevation change of 2 ft/hr when the pool elevation is greater than 802 ft and a decreasing maximum rate of elevation change of zero ft/hr when the pool elevation is less than 802 ft during May21-Jun30.



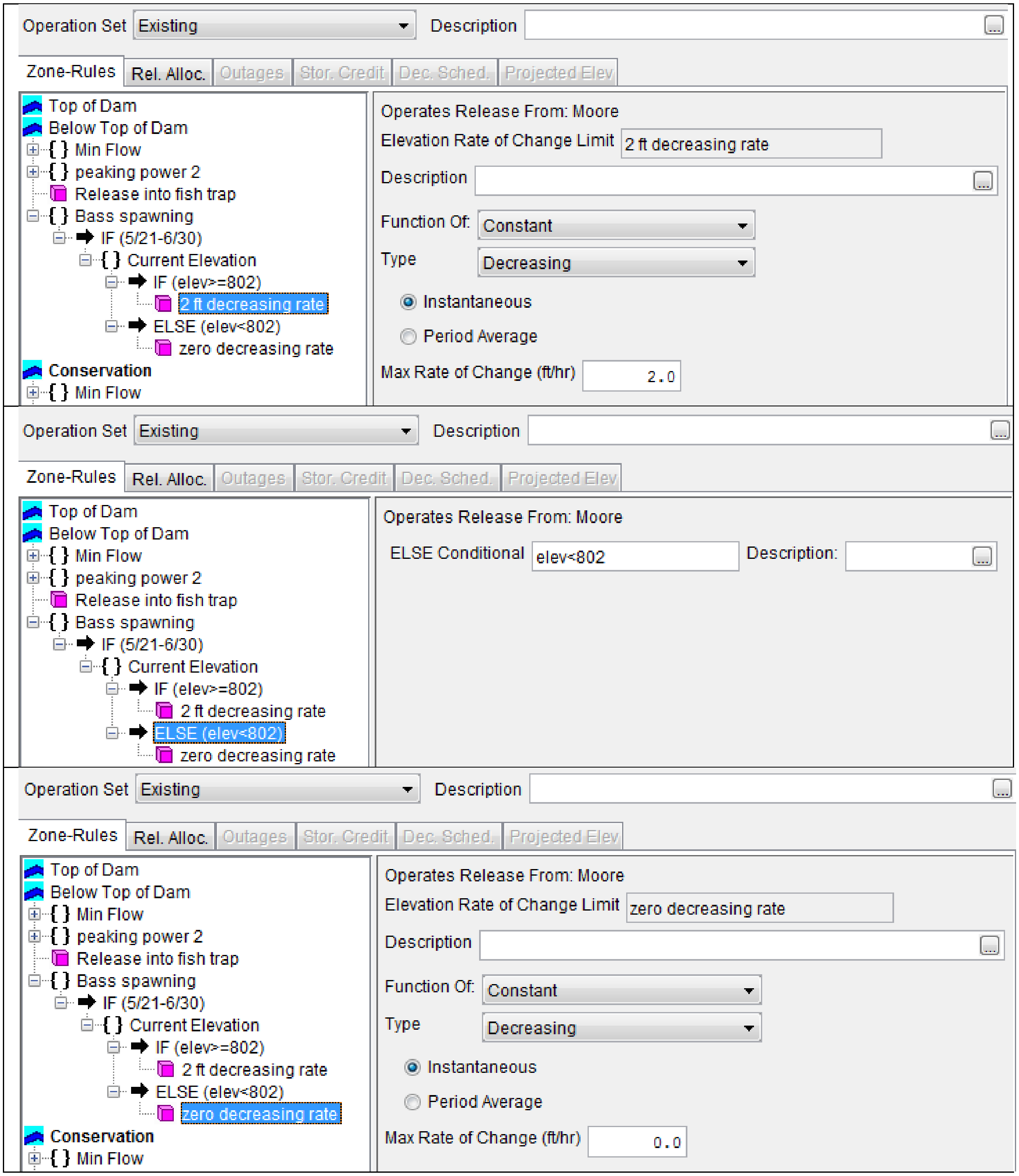


Figure 12: Reservoir Editor: Operations Tab – Existing OpSet – Bass spawning

Nepaug

I. Overview

Nepaug dam is located in the town of New Hartford, CT on the Nepaug River that feeds into the Farmington River. It is owned and operated by the The Metropolitan District of Hartford, Connecticut (MDC) and is used for water supply for the City of Hartford as well as the City of New Britain.

Figure 1 shows the location of Nepaug Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Nepaug Dam.

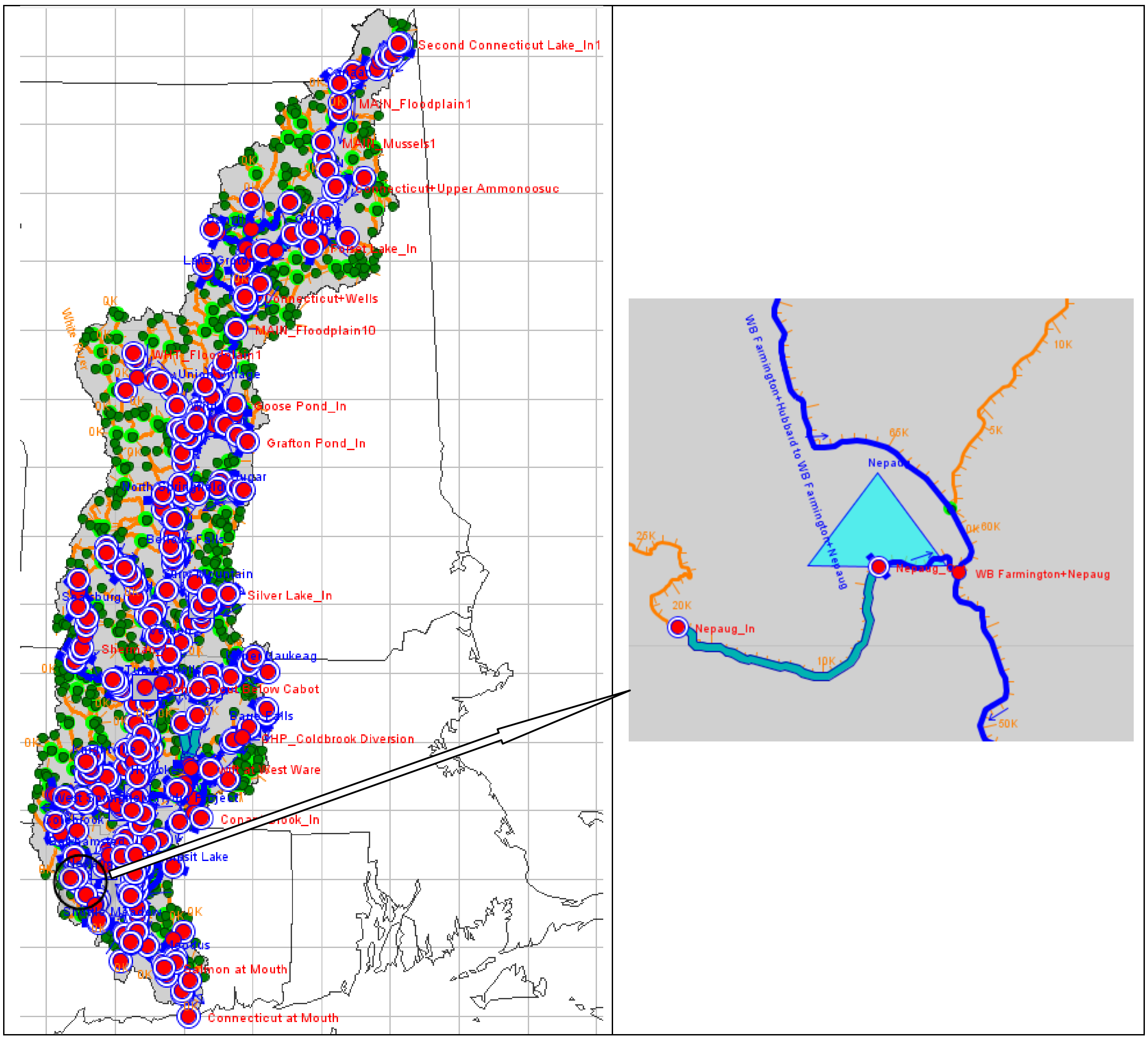


Figure 1: HEC-ResSim Map Display Showing Location of Nepaug

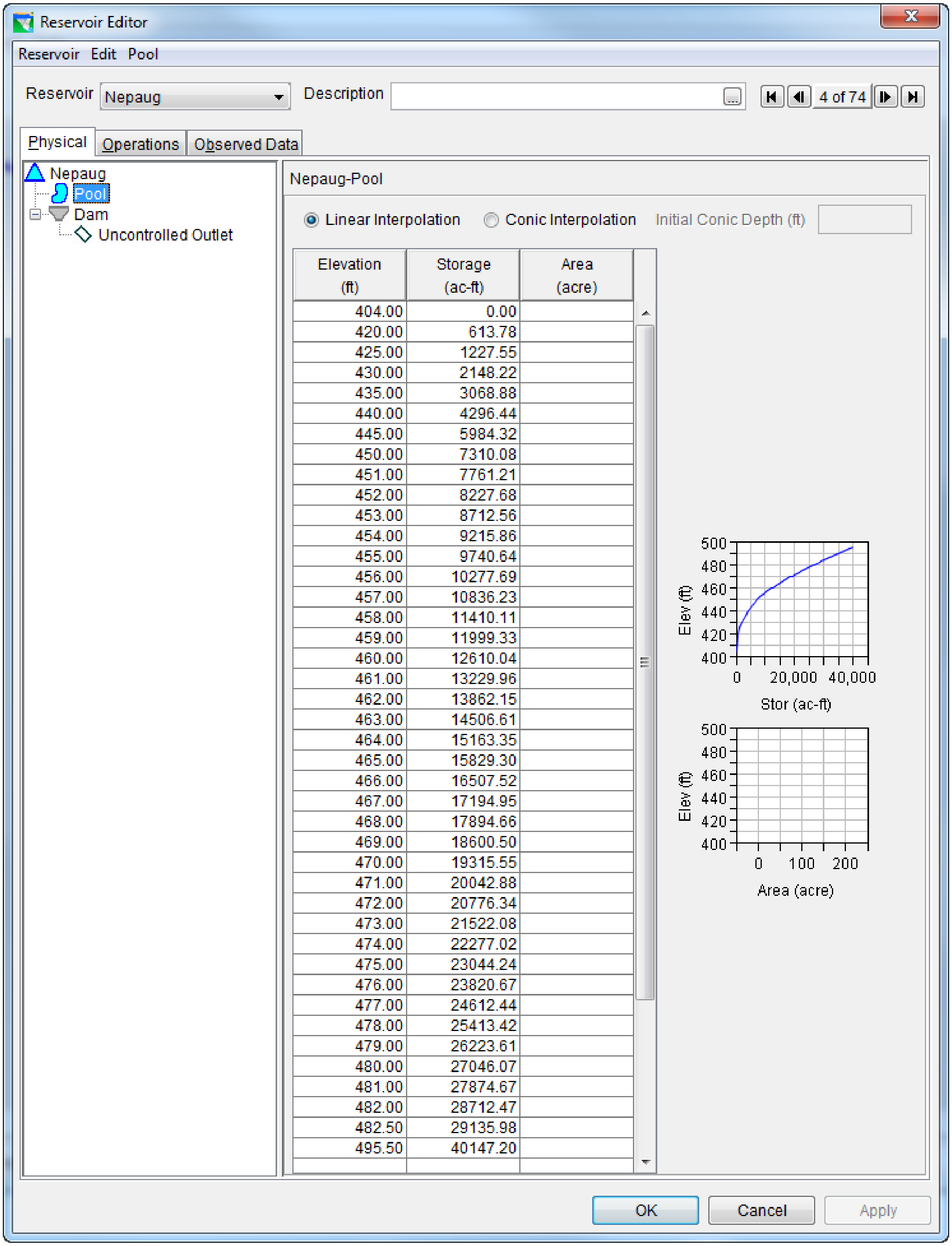
Figure 2: Photo of Nepaug Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[70]. The dam consists of an uncontrolled outlet as shown in Figure 4[71].

[70] MDC 1999.

[71] Data provided by UMASS



Elevation (ft)	Storage (ac-ft)	Area (acre)
404.00	0.00	
420.00	613.78	
425.00	1227.55	
430.00	2148.22	
435.00	3068.88	
440.00	4296.44	
445.00	5984.32	
450.00	7310.08	
451.00	7761.21	
452.00	8227.68	
453.00	8712.56	
454.00	9215.86	
455.00	9740.64	
456.00	10277.69	
457.00	10836.23	
458.00	11410.11	
459.00	11999.33	
460.00	12610.04	
461.00	13229.96	
462.00	13862.15	
463.00	14506.61	
464.00	15163.35	
465.00	15829.30	
466.00	16507.52	
467.00	17194.95	
468.00	17894.66	
469.00	18600.50	
470.00	19315.55	
471.00	20042.88	
472.00	20776.34	
473.00	21522.08	
474.00	22277.02	
475.00	23044.24	
476.00	23820.67	
477.00	24612.44	
478.00	25413.42	
479.00	26223.61	
480.00	27046.07	
481.00	27874.67	
482.00	28712.47	
482.50	29135.98	
495.50	40147.20	

Figure 3: Reservoir Editor: Physical Tab -- Pool

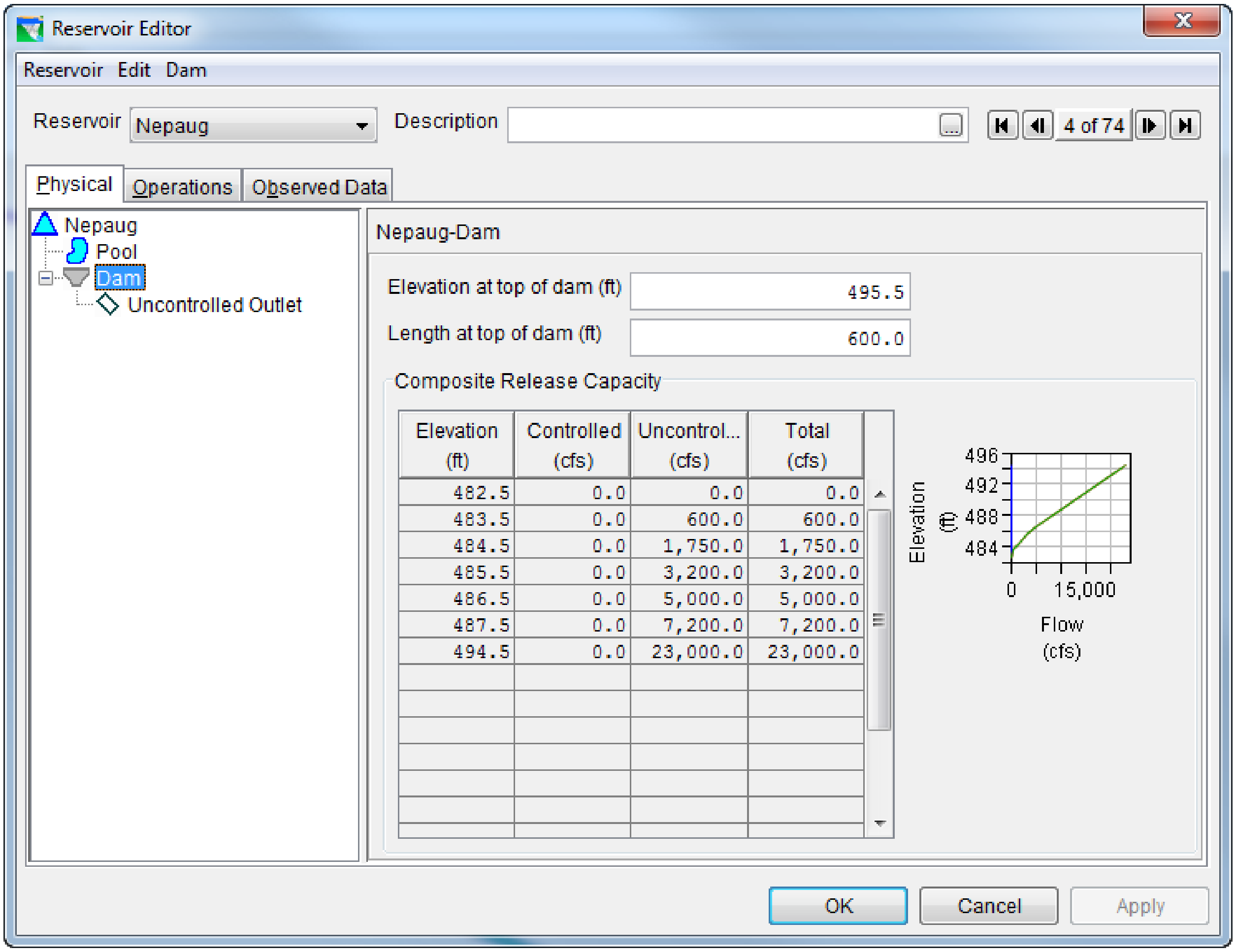


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Nepaug's "Existing Ops" operational zones, which consist of zones of Top of Dam (495.5ft), Conservation (482.5ft), and Inactive zone (417.5ft)[2].

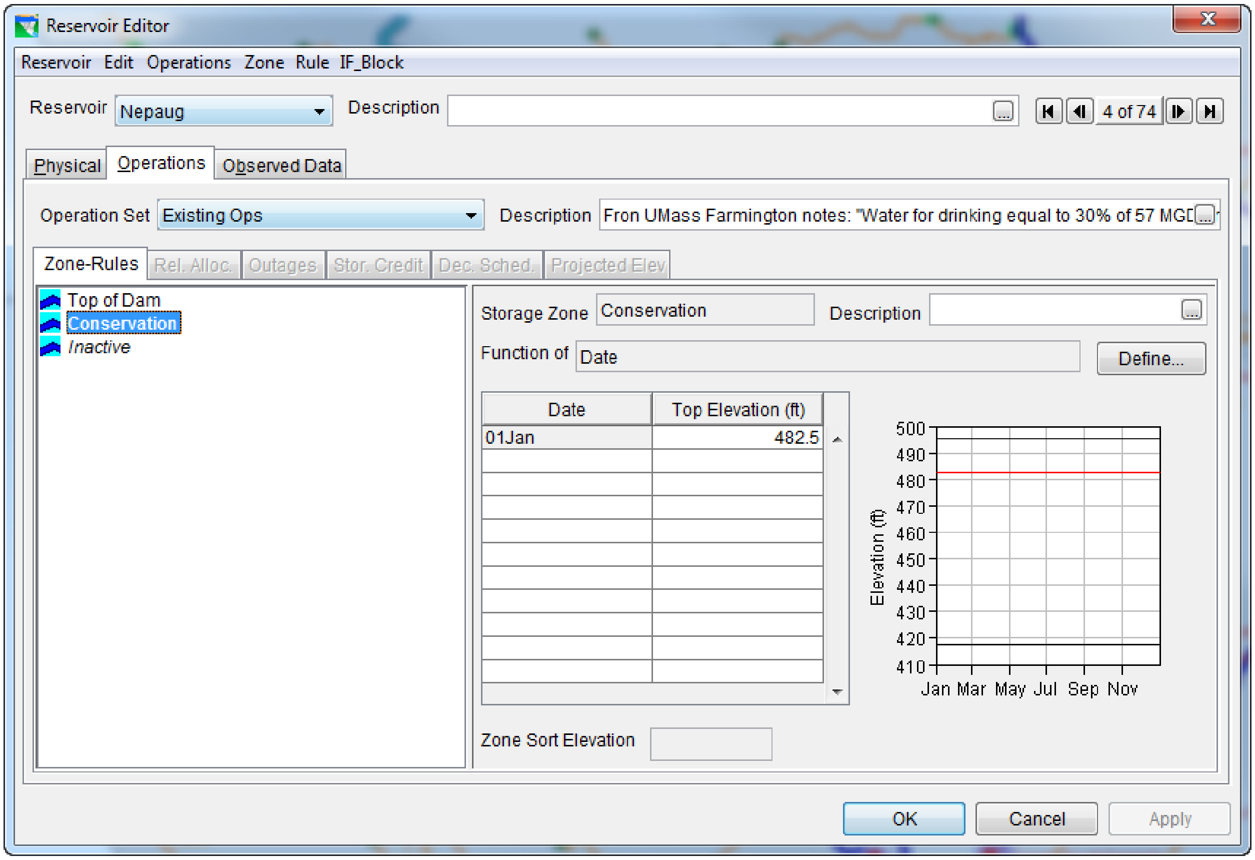


Figure 5: Reservoir Editor: Operations Tab – Existing Ops OpSet

B. Rule Illustrations

The operation set for Nepuag has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

New Home Sewing Machine

I. Overview

New Home Sewing Machine dam is on the Millers River in Orange, MA. The dam is owned by the Chase Industrial Supply Company, Inc. and used is for hydropower generation.

Figure 1 shows the location of New Home Sewing Machine dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of New Home Sewing Machine dam.

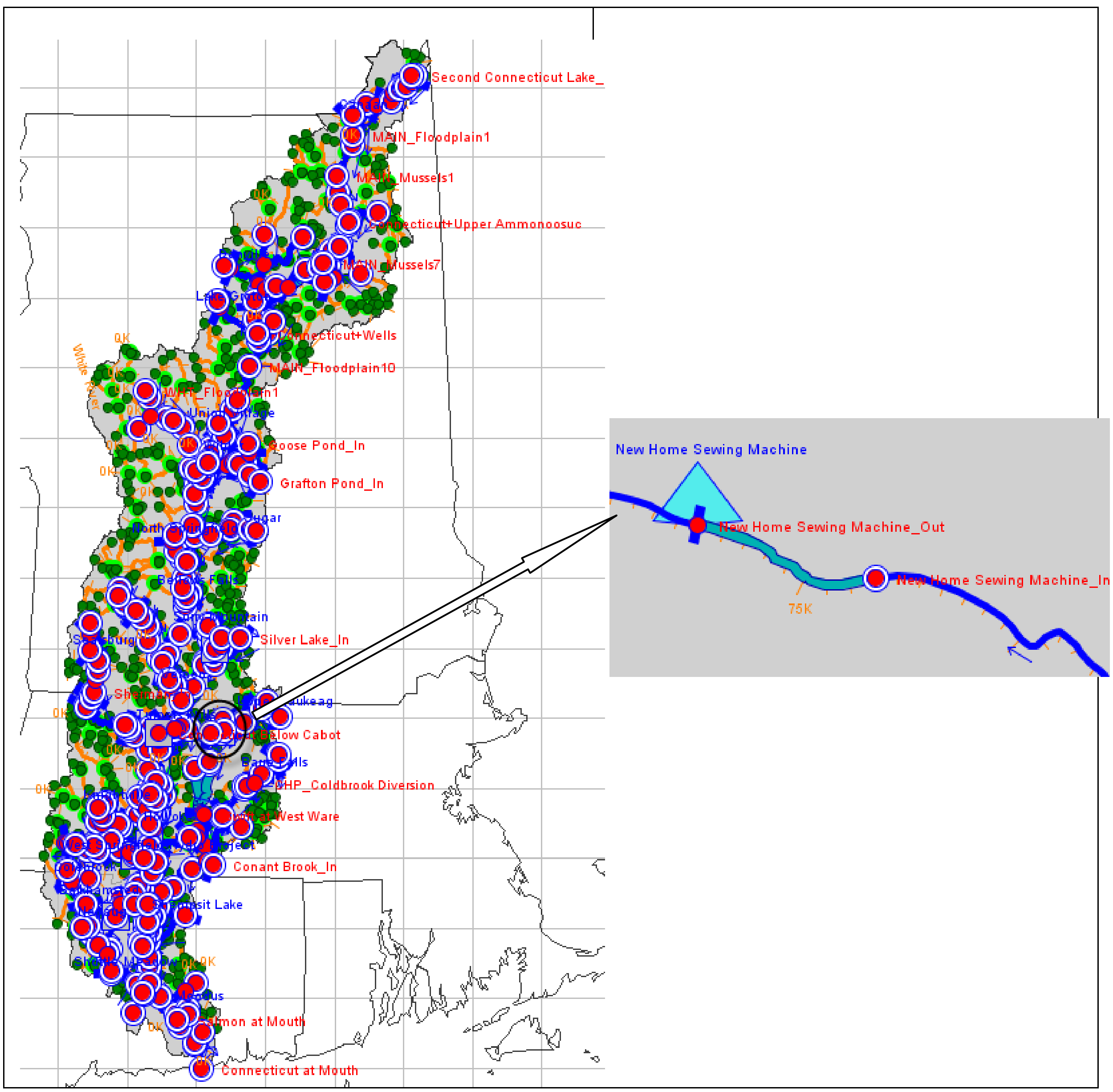


Figure 1: HEC-ResSim Map Display Showing Location of New Home Sewing machine dam

Figure 2: Photo of New Home Sewing Machine dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[72]. The dam consists of five types of outlets: (1) controlled Dam Embankment, (2) controlled outlet, (3) power plant 1,(4) power plant 2, and (5) power plant 3 as shown in Figure 4[73].

[72] National Dam Inspection Program. Phase I Inspection Report. 1980.
[73] Mini-Watt Hydroelectric LLC. Stream Flow Compliance Plan. 2009.

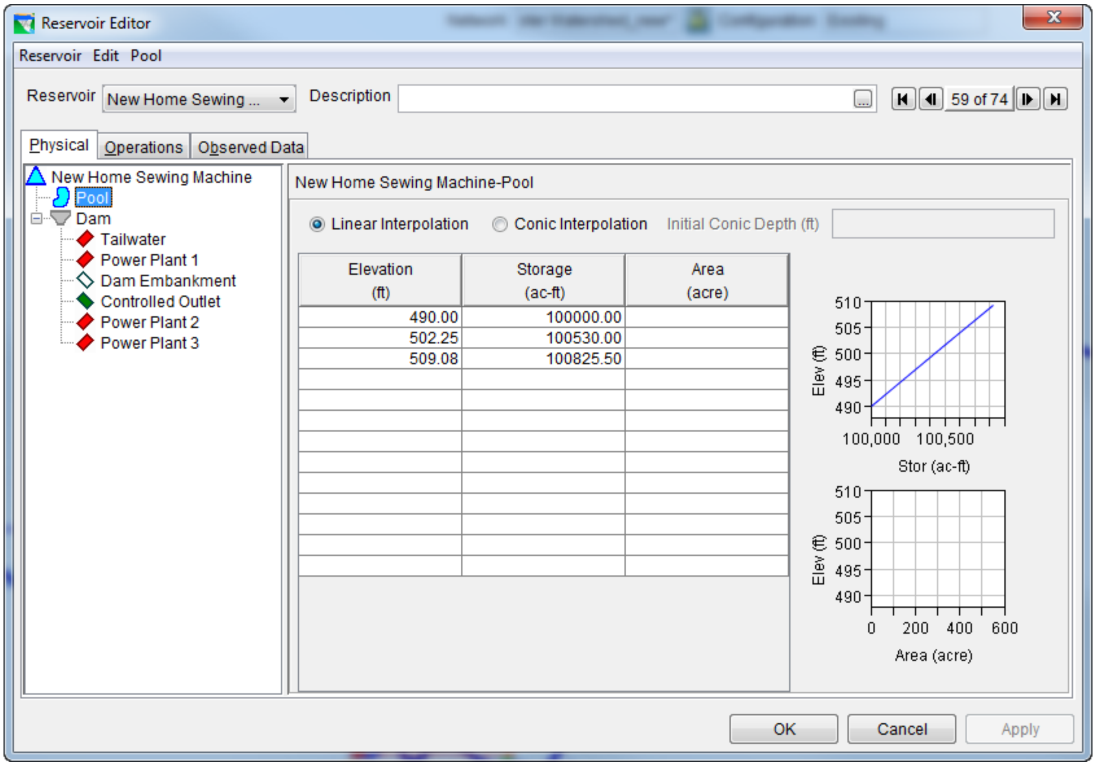


Figure 3: Reservoir Editor: Physical Tab -- Pool

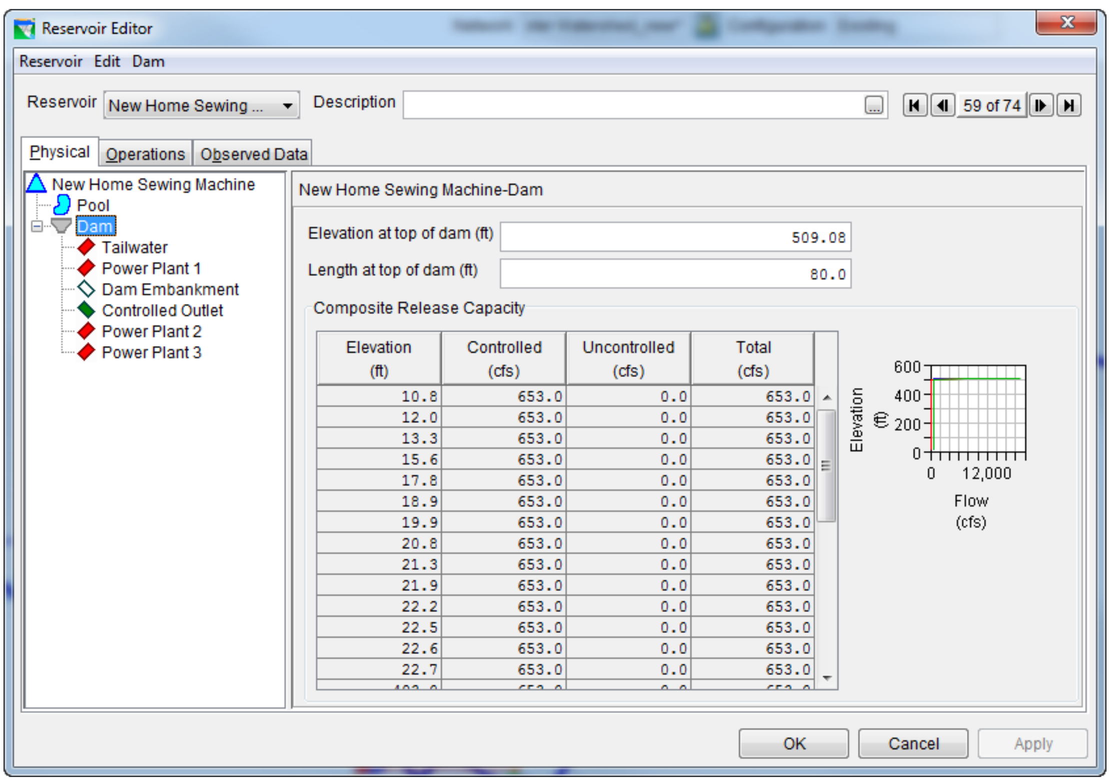


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 4 shows the definition of New Home Sewing machine's "Existing Ops" operational zones, which consist of zones of Top of dam (509.08 t), Flood Control (497.3 ft), Conservation (493 ft), and Inactive zone (491 ft)[1].

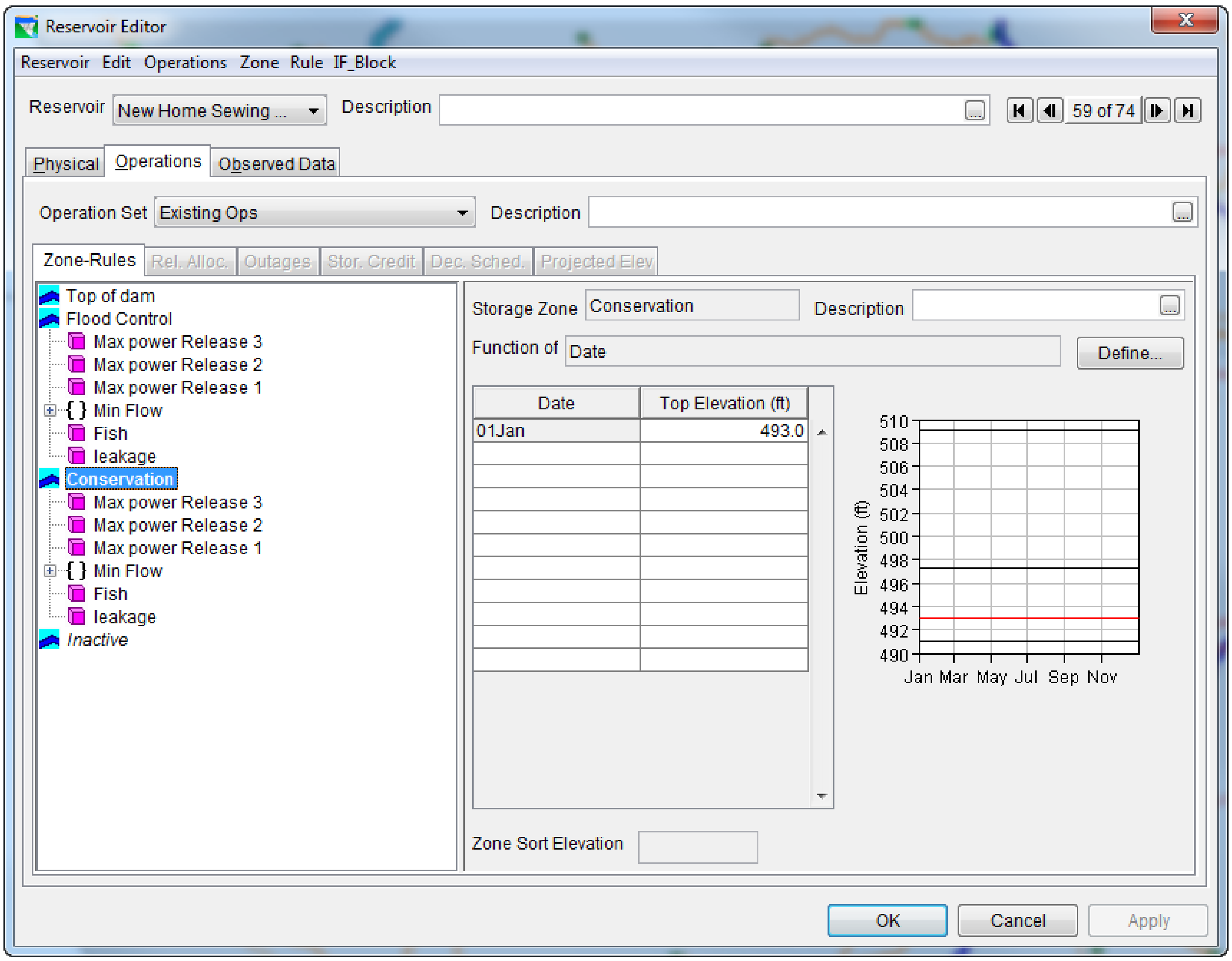


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Guide Curve.

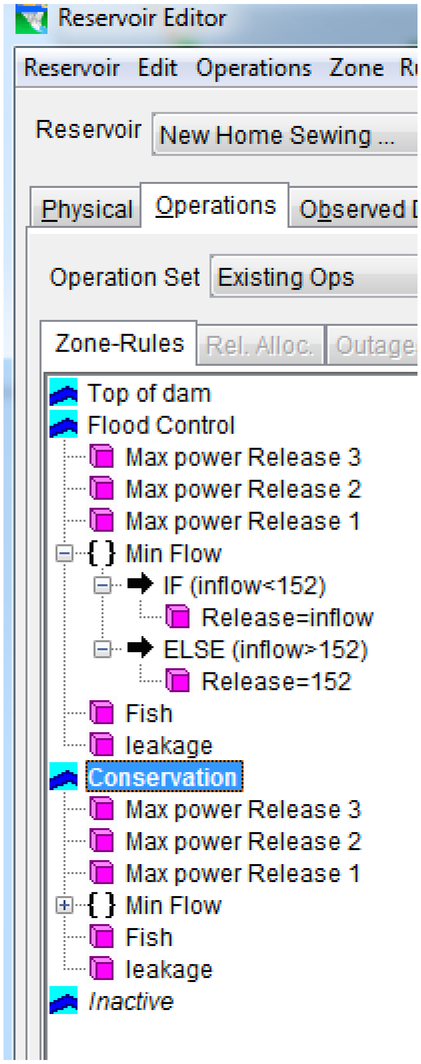


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Max power Release 3

Figure 7 shows the content of "Max power Release 3" rule. It assigns 600 cfs as a maximum allowable release from power plant 3.

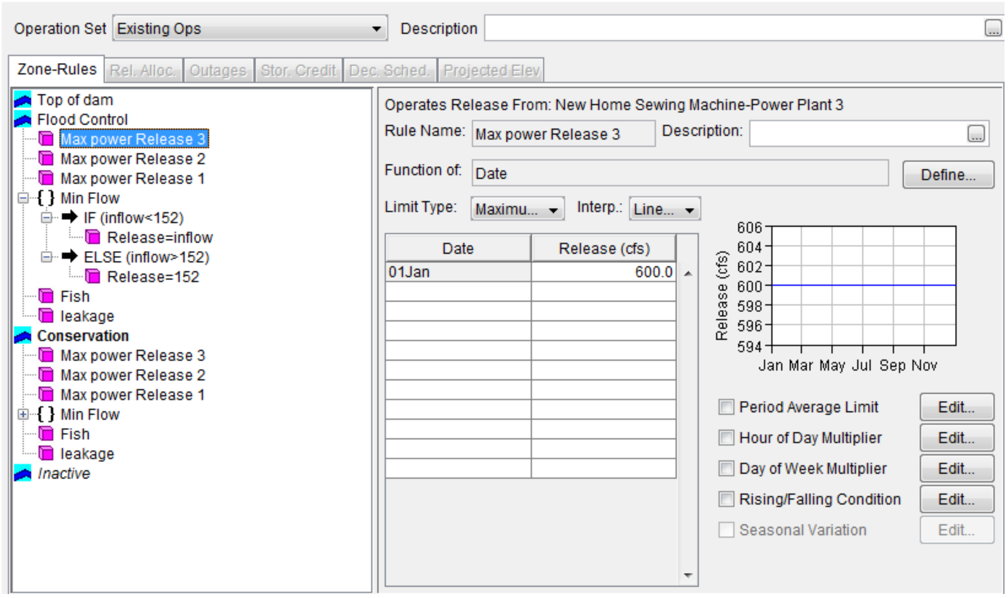


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max power Release 3

2. Max power Release 2

Figure 8 shows the content of "Max power Release 2" rule. It assigns 600 cfs as a maximum allowable release from power plant 2.

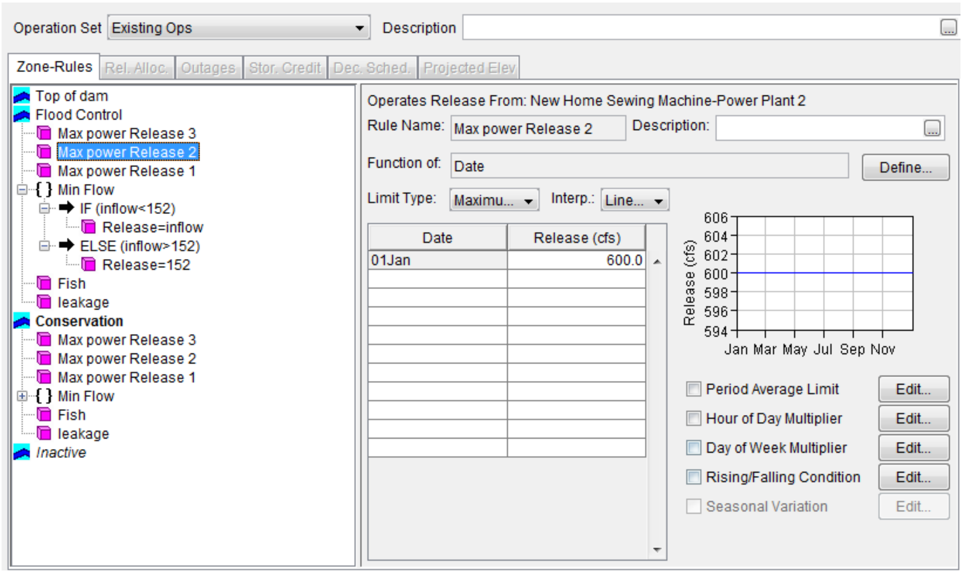


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max power Release 2

3. *Max power Release 1*

Figure 9 shows the content of “Max power Release 1” rule. It assigns 600 cfs as a maximum allowable release from power plant 1.

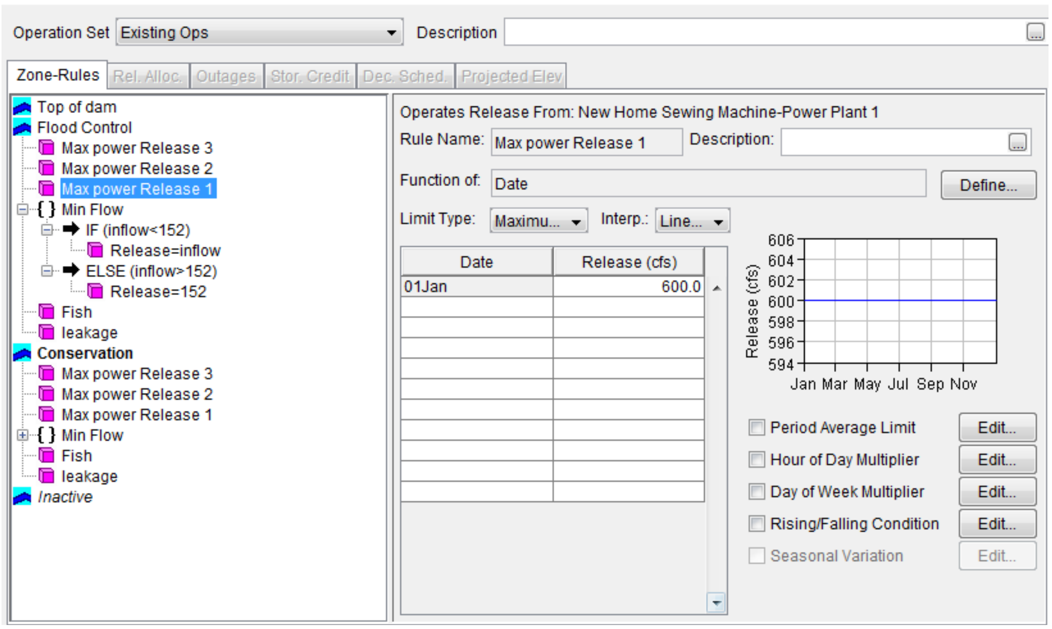
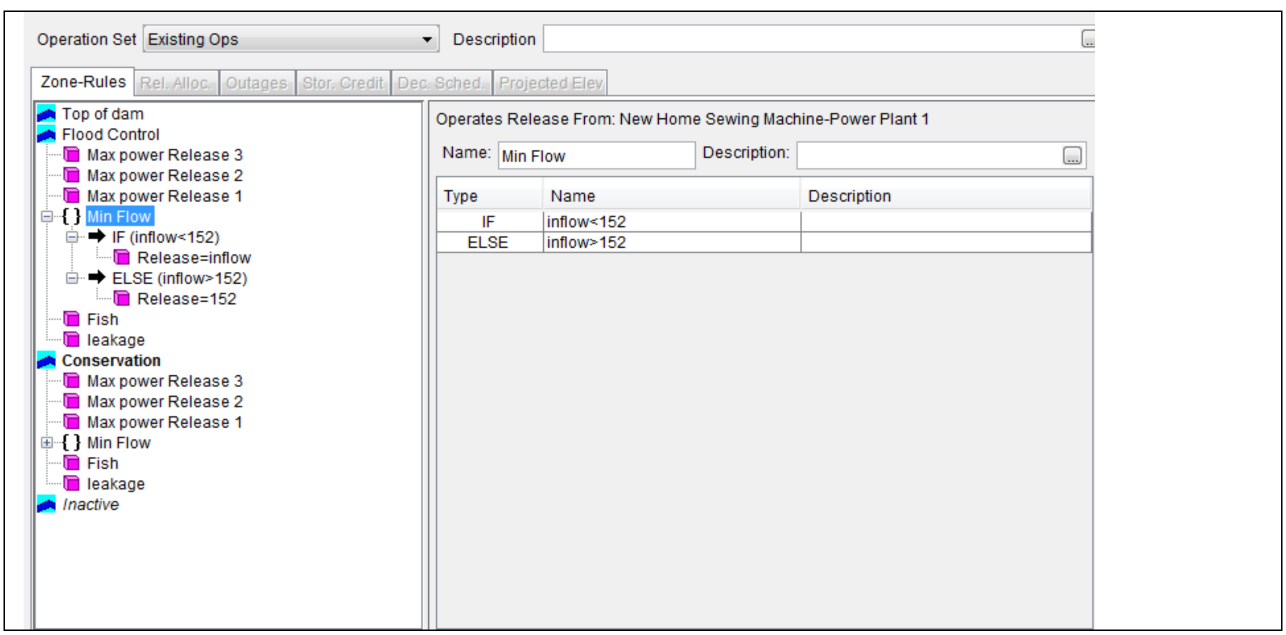
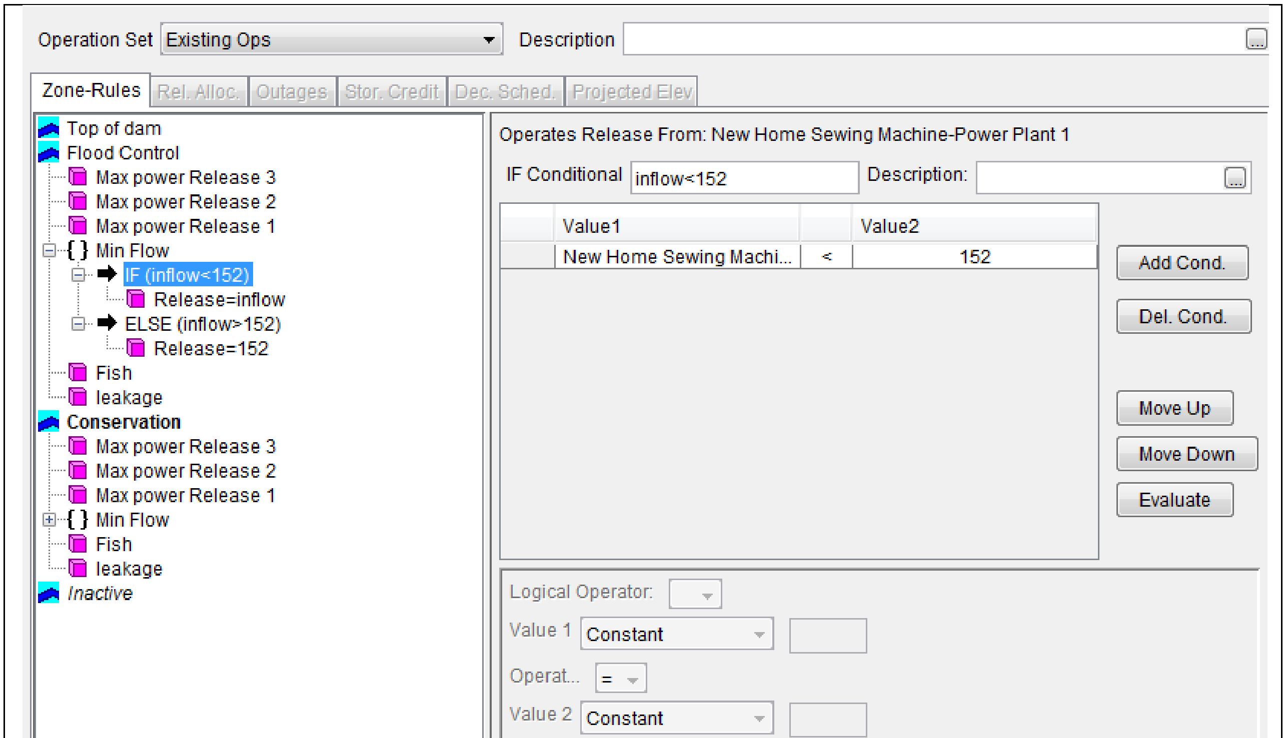


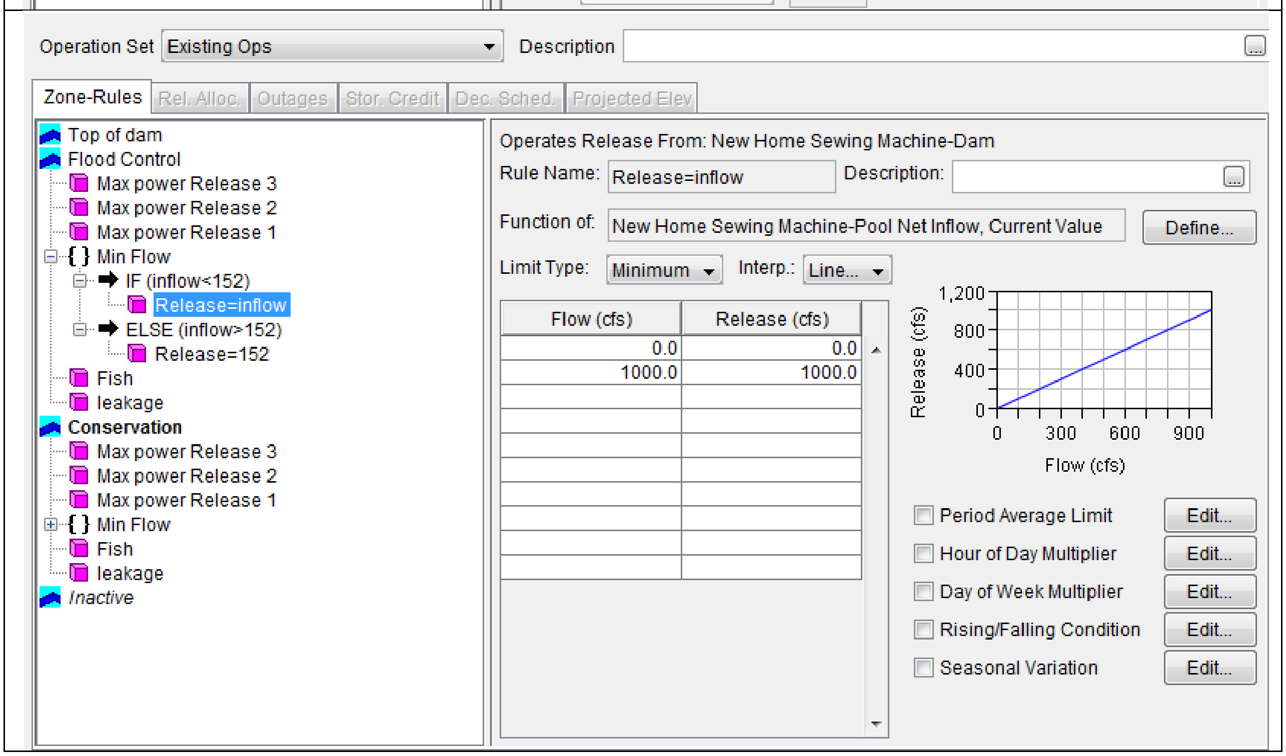
Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max power Release 1

4. *Min Flow*

Figure 10 shows the content of “Min Flow” rule. It releases inflow when inflow is less than 152 cfs and 152 cfs when inflow is greater than 152 cfs.




Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Flood Control
Max power Release 3
Max power Release 2
Max power Release 1
{ } Min Flow
IF (inflow<152)
Release=inflow
ELSE (inflow>152)
Release=152
Fish
leakage
Conservation
Max power Release 3
Max power Release 2
Max power Release 1
{ } Min Flow
Fish
leakage
Inactive
Operates Release From: New Home Sewing Machine-Power Plant 1
IF Conditional
inflow<152
Description:
Value1
Value2
New Home Sewing Machi...
<
152
Add Cond.
Del. Cond.
Move Up
Move Down
Evaluate
Logical Operator:
Value 1
Constant
Operat...
=
Value 2
Constant


Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Flood Control
Max power Release 3
Max power Release 2
Max power Release 1
{ } Min Flow
IF (inflow<152)
Release=inflow
ELSE (inflow>152)
Release=152
Fish
leakage
Conservation
Max power Release 3
Max power Release 2
Max power Release 1
{ } Min Flow
Fish
leakage
Inactive
Operates Release From: New Home Sewing Machine-Dam
Rule Name:
Release=inflow
Description:
Function of:
New Home Sewing Machine-Pool Net Inflow, Current Value
Define...
Limit Type:
Minimum
Interp.:
Line...
Flow (cfs)
Release (cfs)
0.0
0.0
1000.0
1000.0
1,200
800
400
0
0
300
600
900
Release (cfs)
Flow (cfs)
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

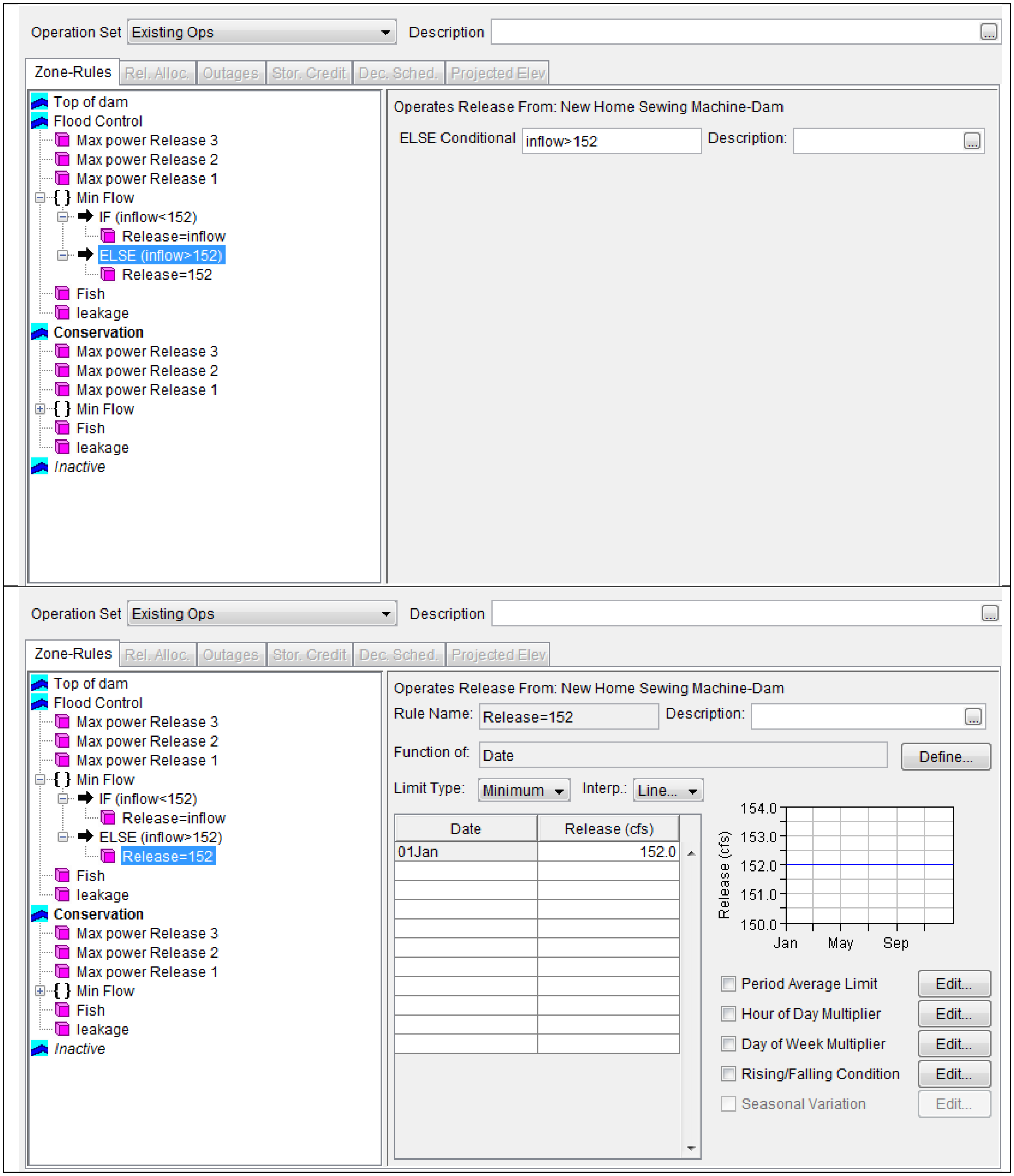


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow

5. *Fish*

Figure 11 shows the content of “Fish” rule. It shows the minimum release from dam for Fish.

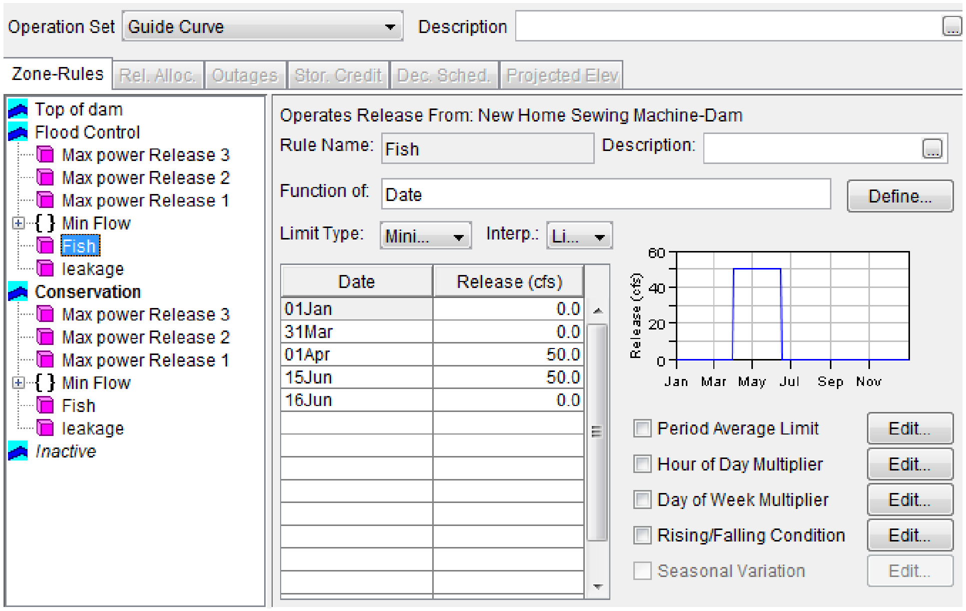


Figure 11: Reservoir Editor: Operations Tab – Guide Curve OpSet – Fish

6. *leakage*

Figure 12 shows the content of “leakage” rule. It shows the minimum release from dam for leakage.

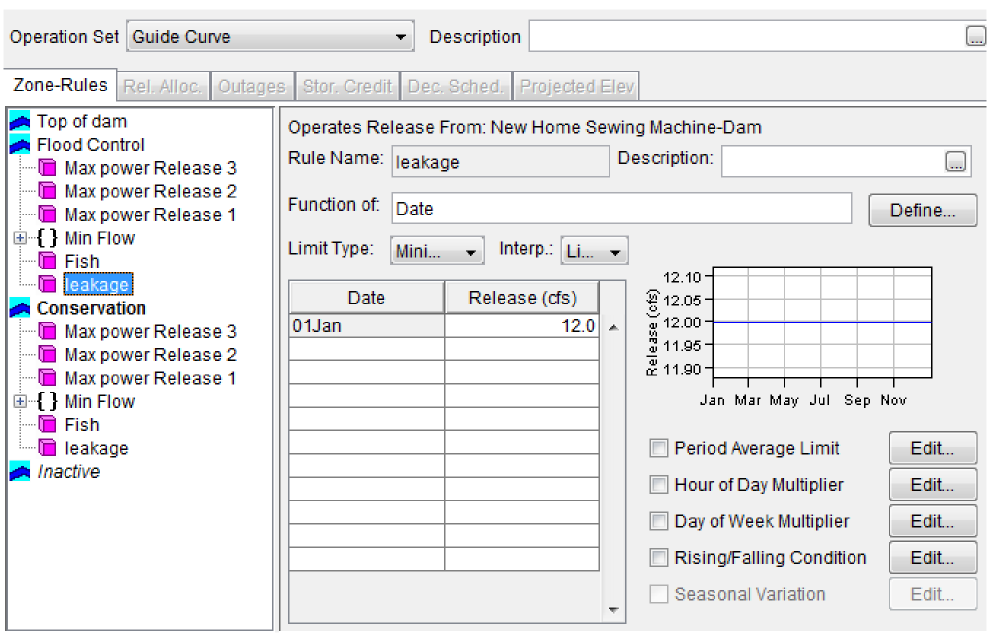


Figure 12: Reservoir Editor: Operations Tab – Guide Curve OpSet – leakage

North Hartland

I. Overview

North Hartland Dam is a dam in Hartland, Windsor County, Vermont. It was constructed in 1961 by the US Army Corps of Engineers and is still owned and operated by the Corps. It is primarily used for flood control purposes but is also used for recreation.

Figure 1 shows the location of North Hartland Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the dam.

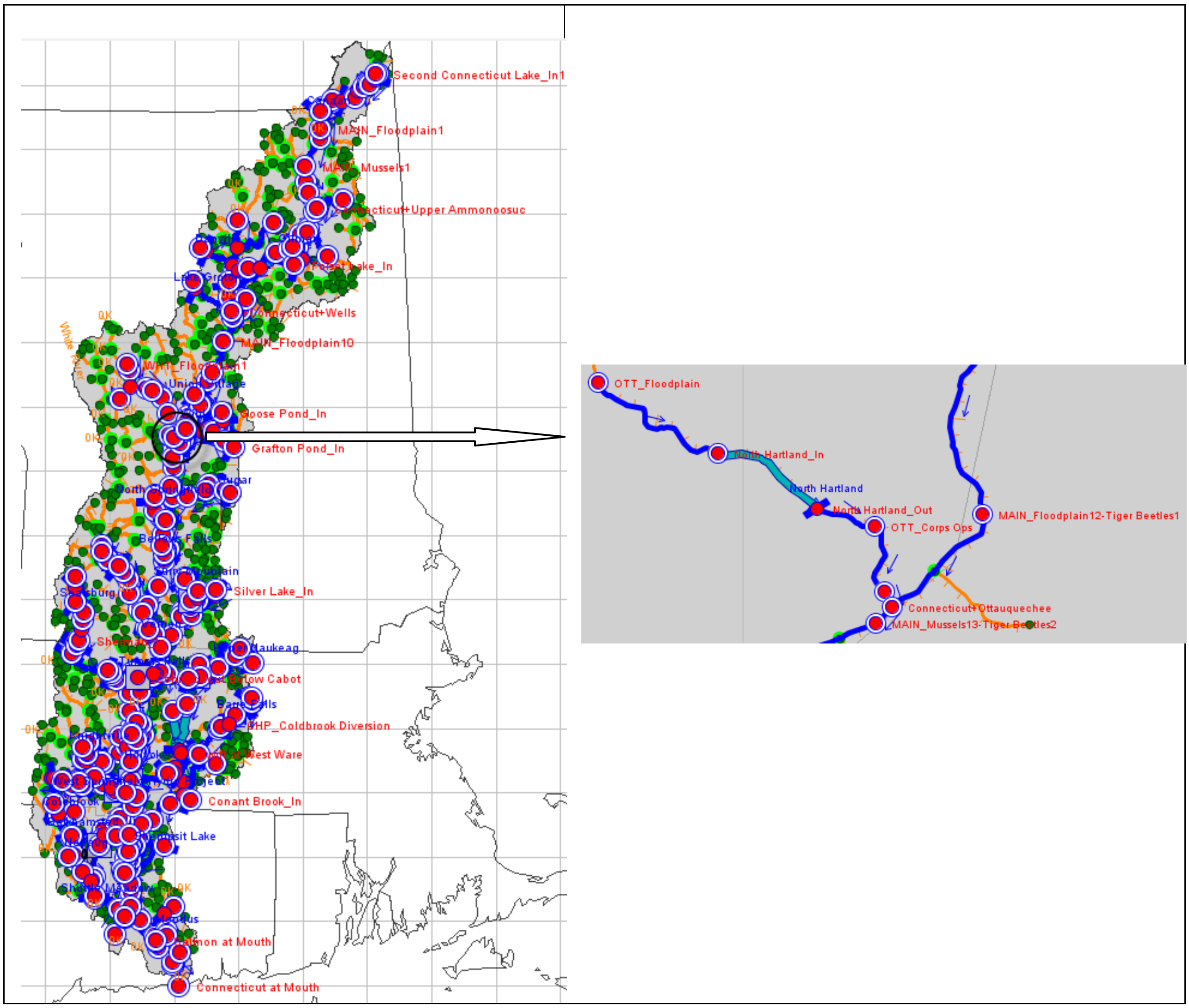


Figure 1: HEC-ResSim Map Display Showing Location of North Hartland dam

Figure 2: Photo of North Hartland Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled slide gates, and (2) uncontrolled outlet, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[74].

[74] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

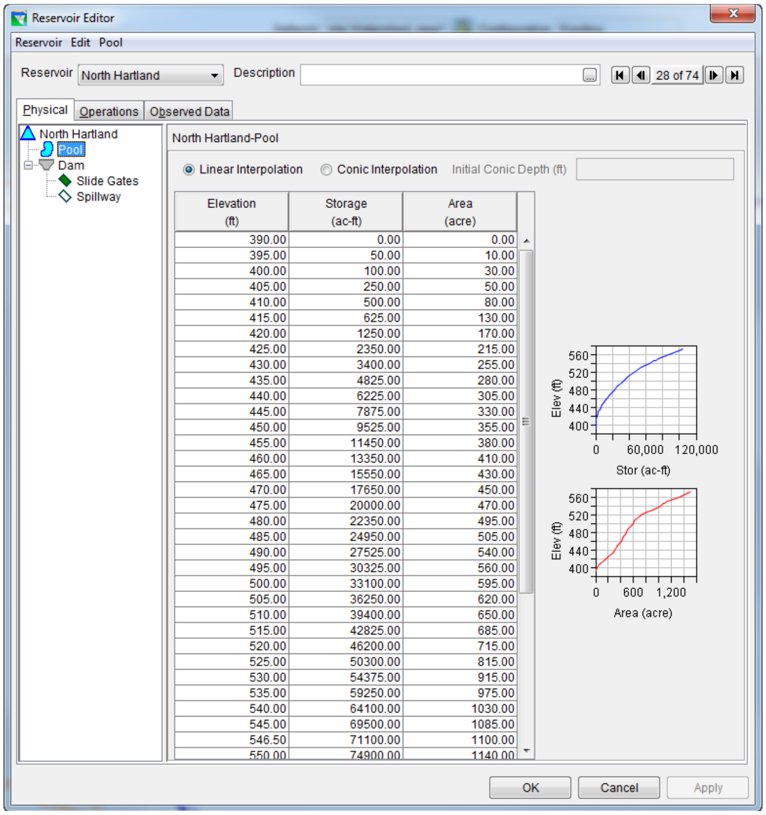


Figure 3: Reservoir Editor: Physical Tab -- Pool

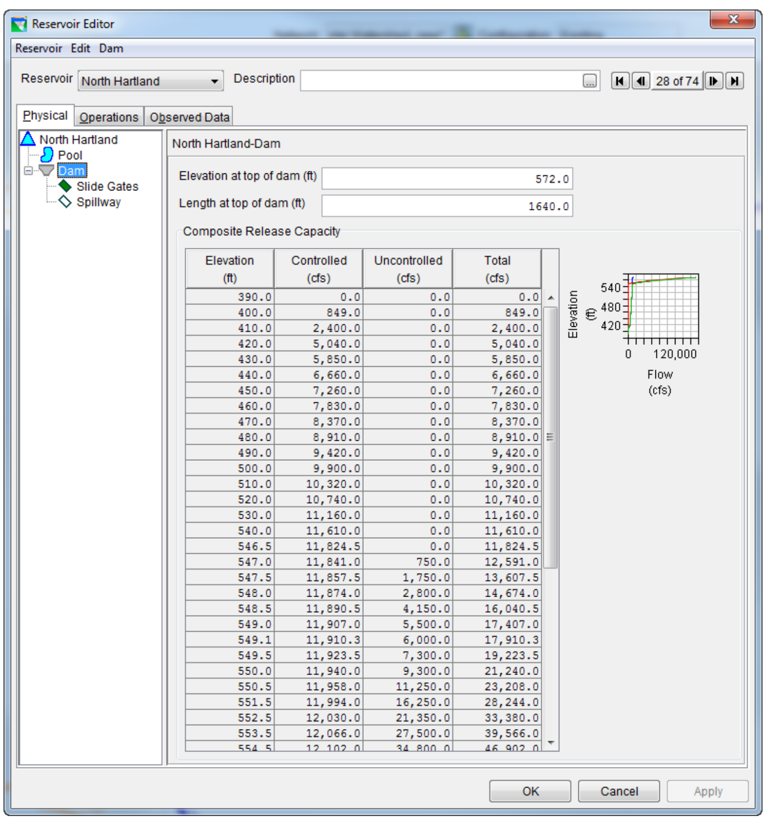


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of North Hartland's "ExistingOps" operational zones, which consist of zones of Top of dam (572 ft), Flood Control (546.5 ft), Conservation (426 ft), and Inactive zone (390 ft).

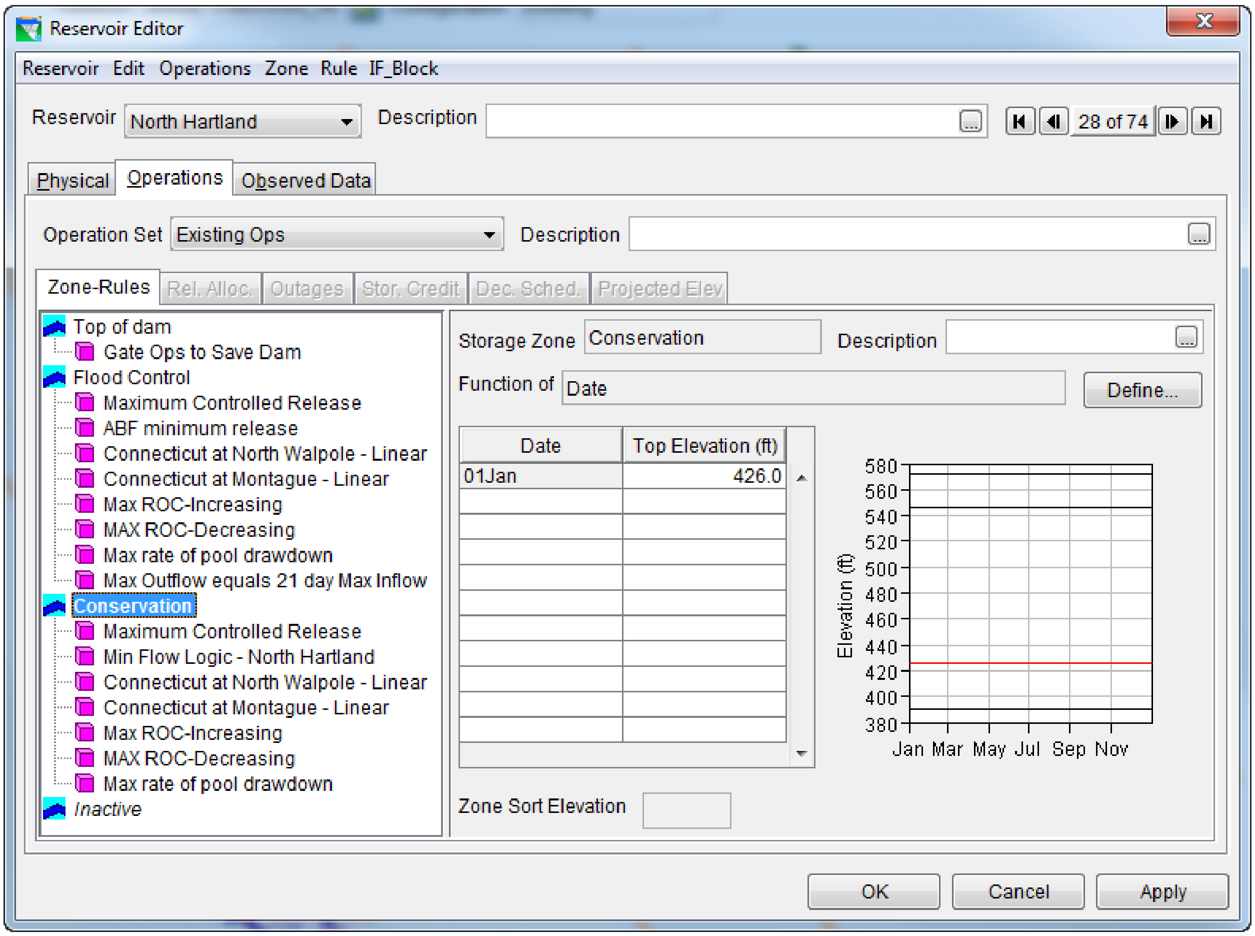


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

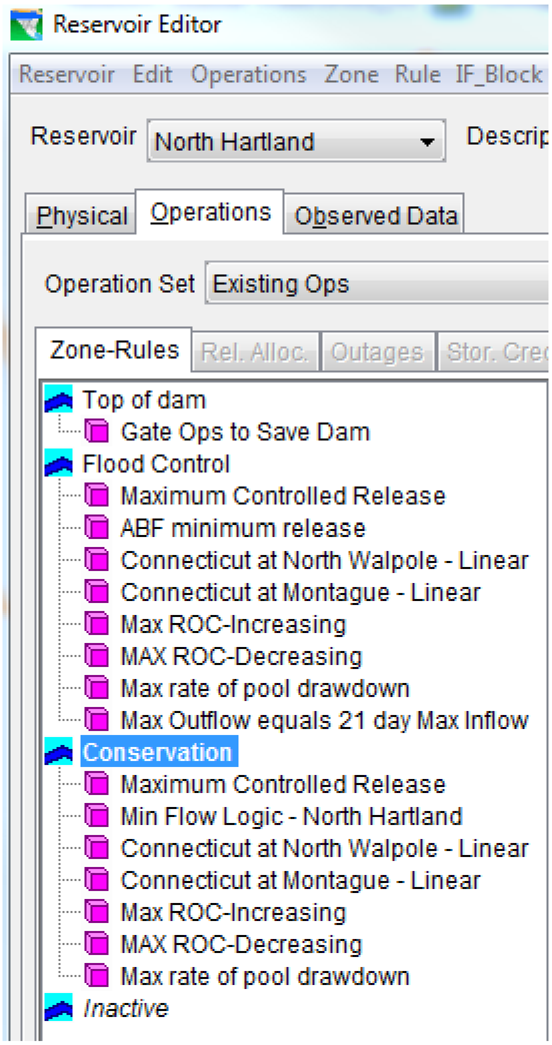


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Gate Ops to Save Dam

Figure 7 shows the content of "Gate Ops to Save Dam" rule. This rule represents the maximum allowable release from Slide gates as a function of pool elevation when the pool is in Top of dam zone.

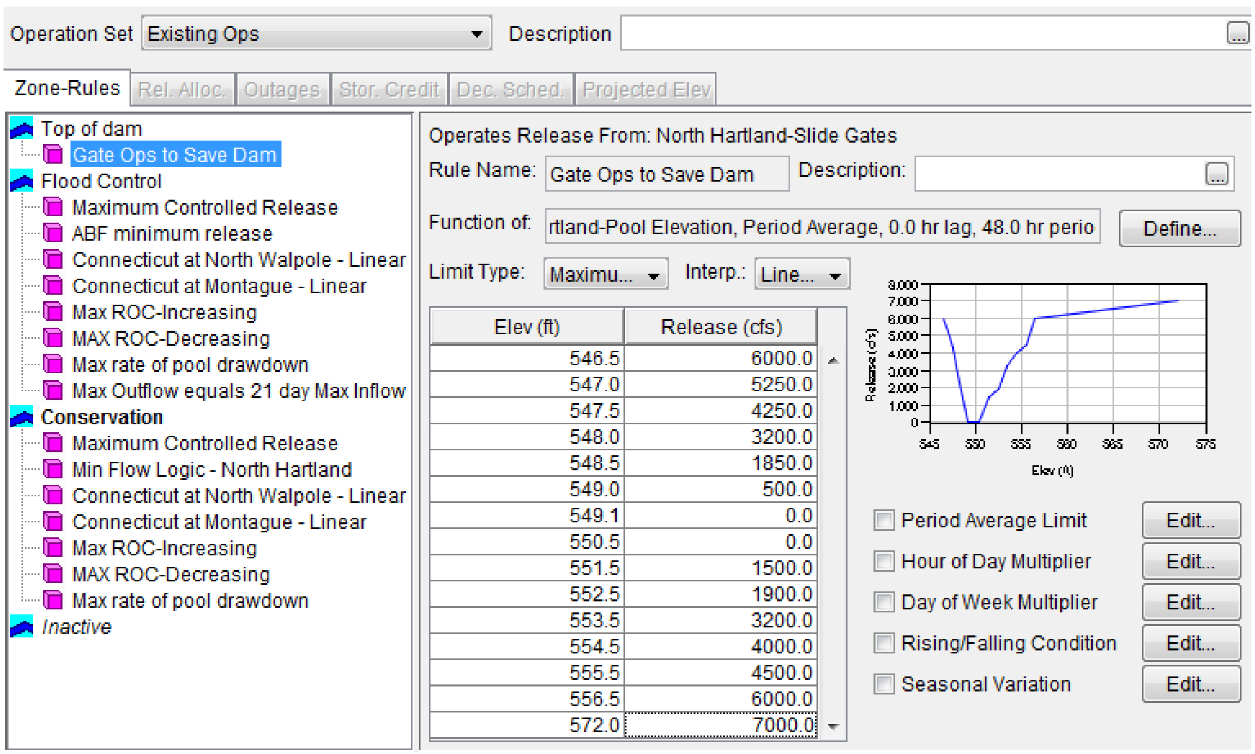


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet –Gate Ops to Save Dam

2. *Maximum Controlled Release*

Figure 8 shows the content of “Maximum Controlled Release” rule. This rule represents the maximum allowable release from Slide gates.

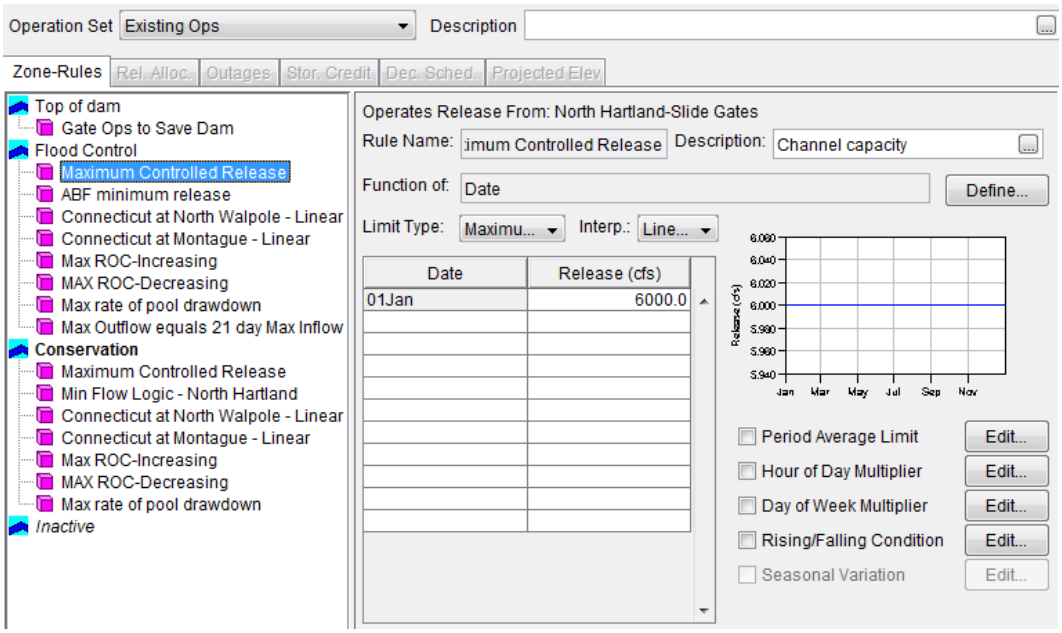


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet –Maximum controlled Release

3. *ABF minimum release*

Figure 9 shows the content of “ABF minimum release” rule. This rule represents the minimum required release from slide gates during flood control operations.

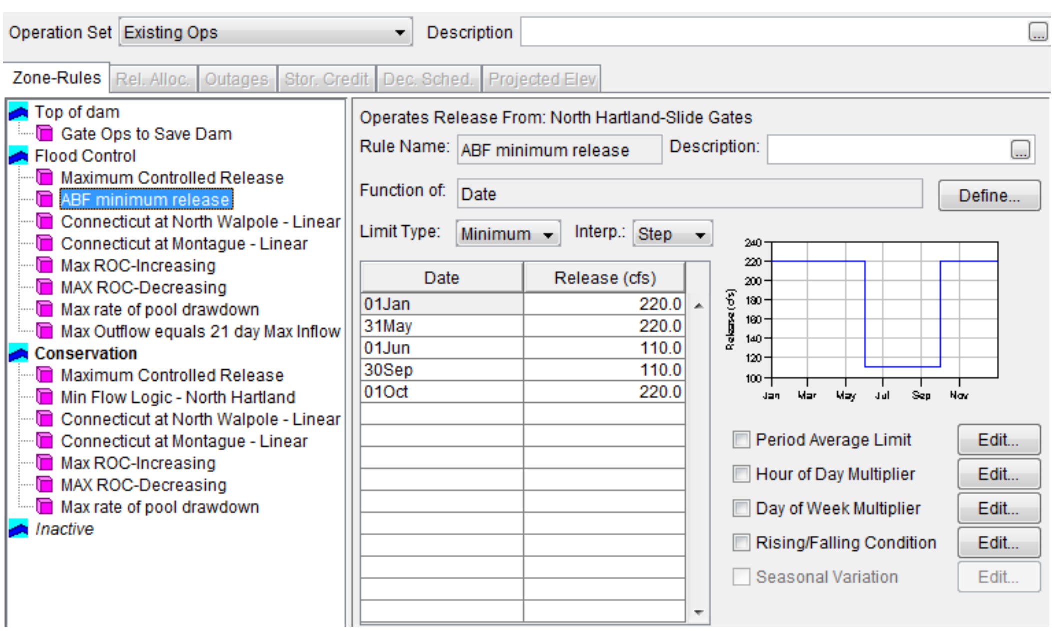


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet –ABF minimum release

4. Connecticut at North Walpole-Linear

Figure 10 shows the content of “Connecticut at North Walpole-Linear” rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at North Walpole. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

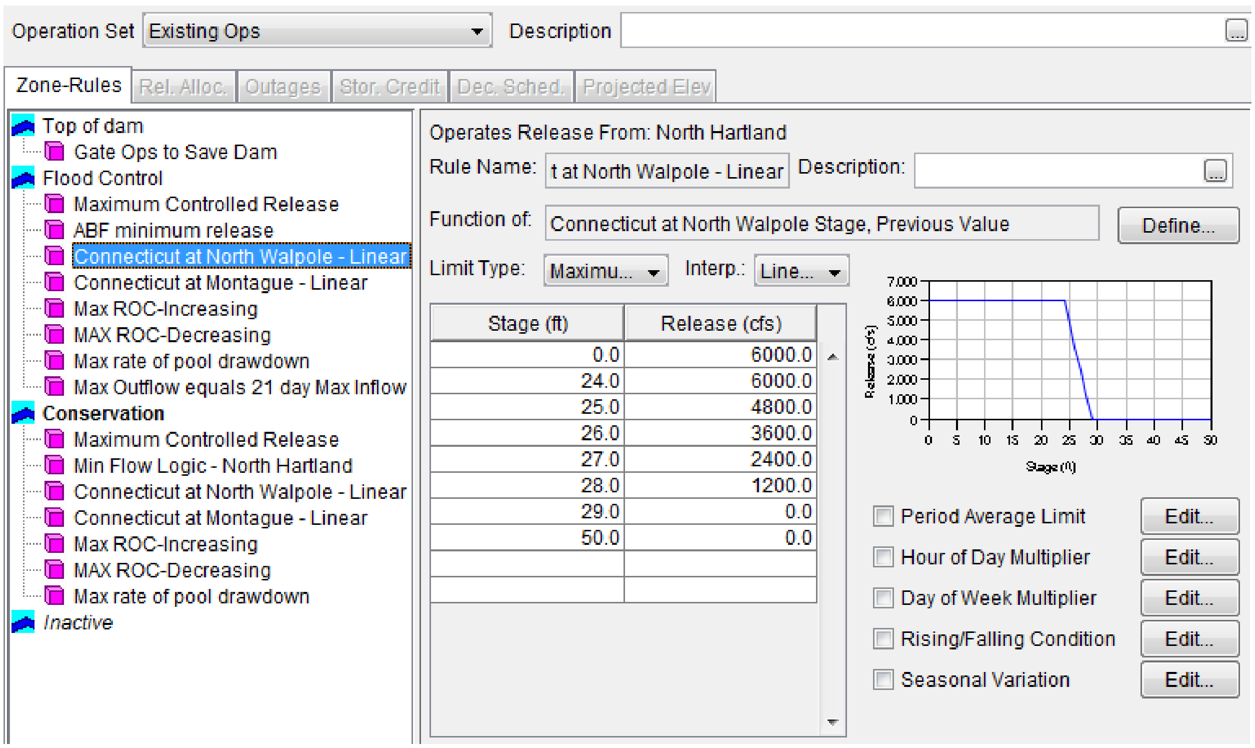


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet –Connecticut at North Walpole-Linear

5. *Connecticut at Montague-Linear*

Figure 11 shows the content of "Connecticut at Montague-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montague. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

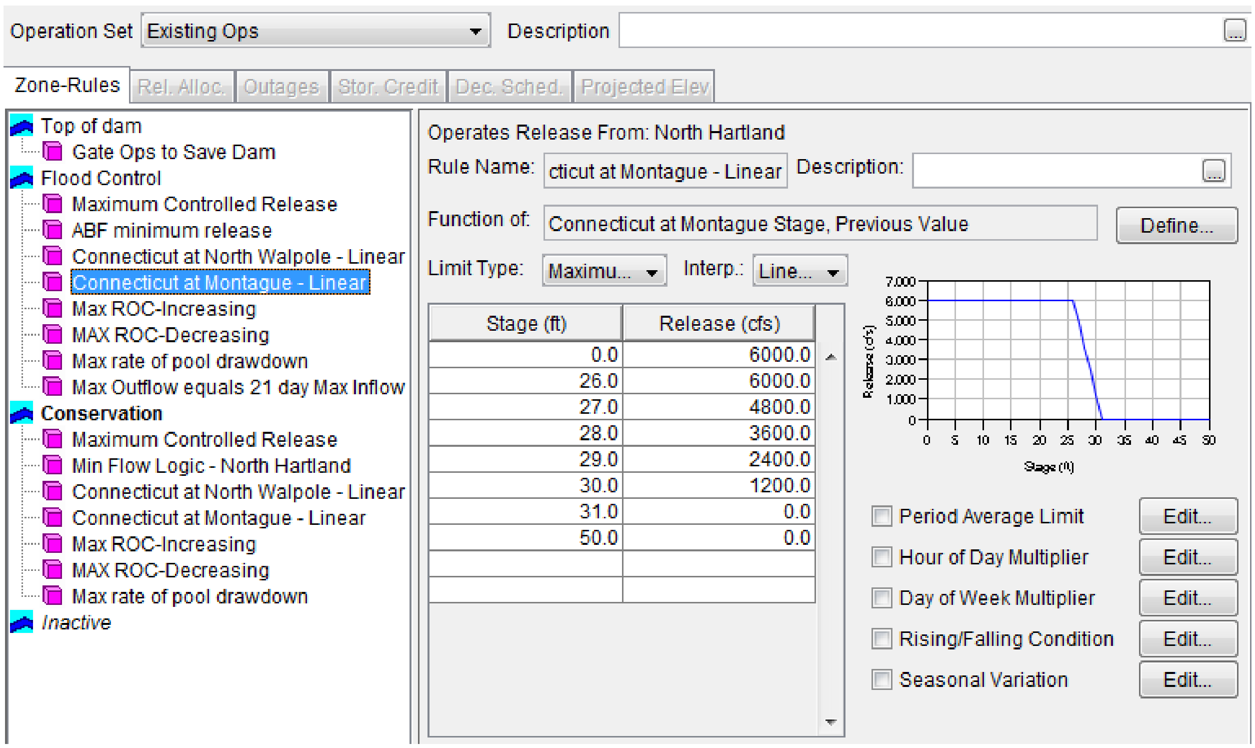


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet –Connecticut at Montague-Linear

6. *Max ROC-Increasing*

Figure 12 shows the content of "Max ROC-Increasing" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from North Hartland dam.

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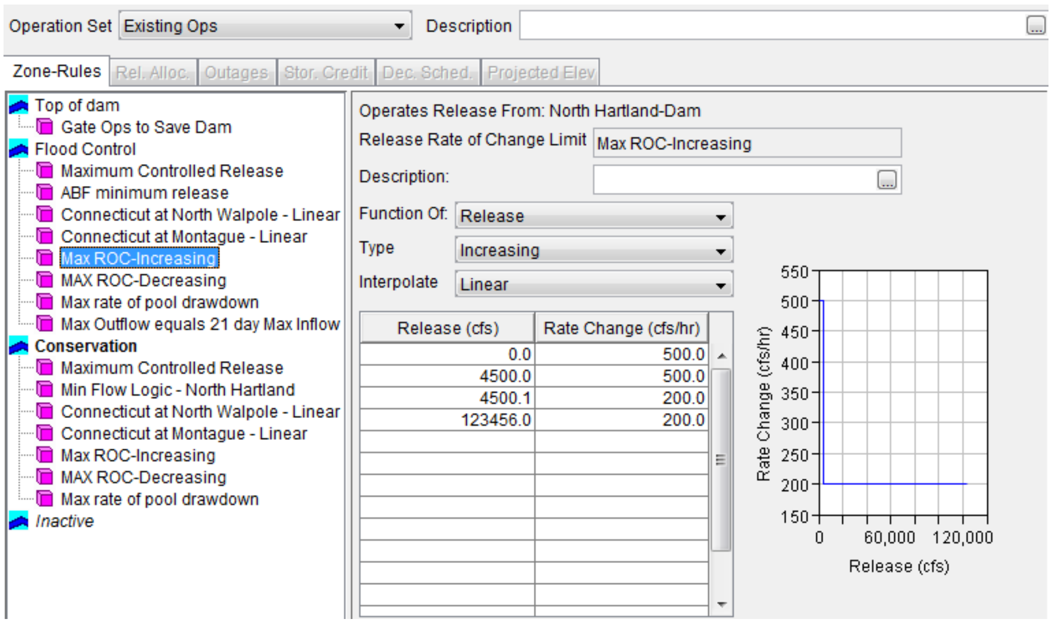


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max ROC-Increasing

7. *Max ROC-Decreasing*

Figure 13 shows the content of "Max ROC-Decreasing" rule. This rule shows the maximum allowable decreasing release rate of change.

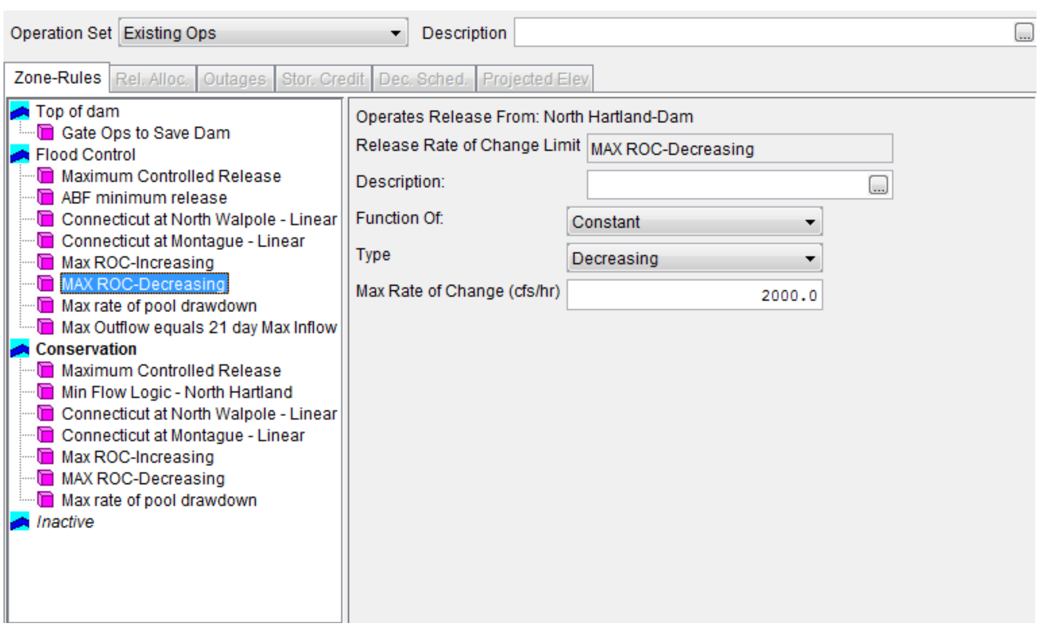


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max ROC-Decreasing

8. *Max rate of pool drawdown*

Figure 14 shows the content of “Max rate of pool drawdown” rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

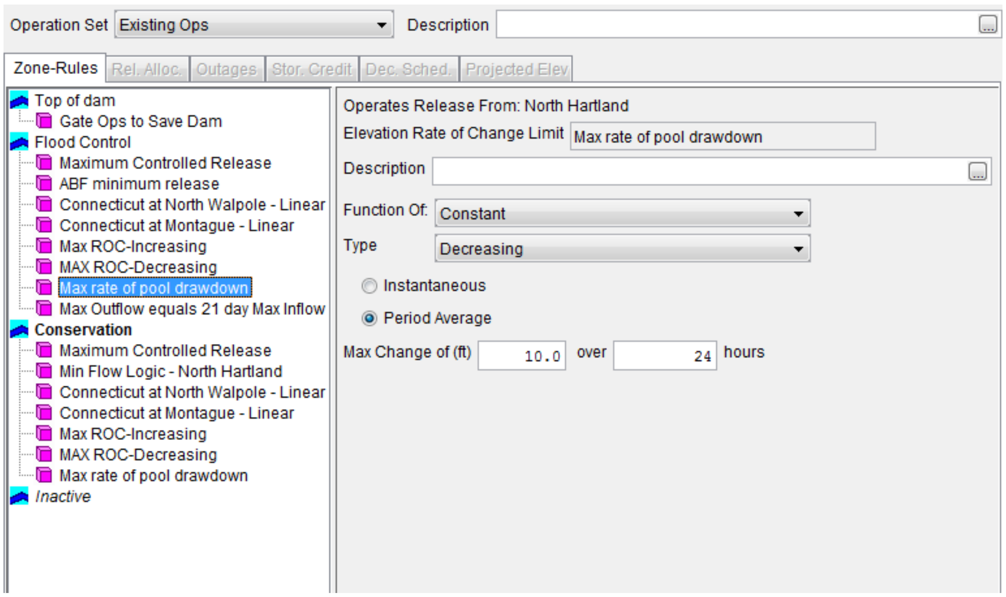


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max rate of pool drawdown

9. *Max Outflow equals 21 day Max Inflow*

Figure 15 shows the content of “Max Outflow equals 21 day Max Inflow” rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

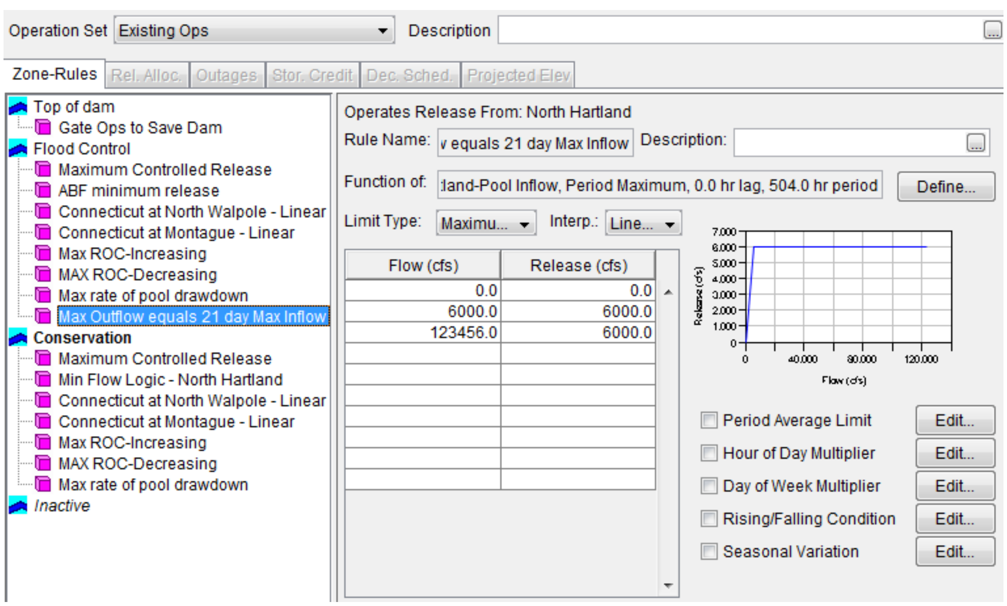


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max Outflow equals 21 day Max Inflow

10. Min Flow Logic-North Hartland

Figure 16 shows the content of "Min Flow Logic-North Hartland" rule. This rule describes required seasonal minimum flows from controlled outlets as a function of inflow at North Hartland.

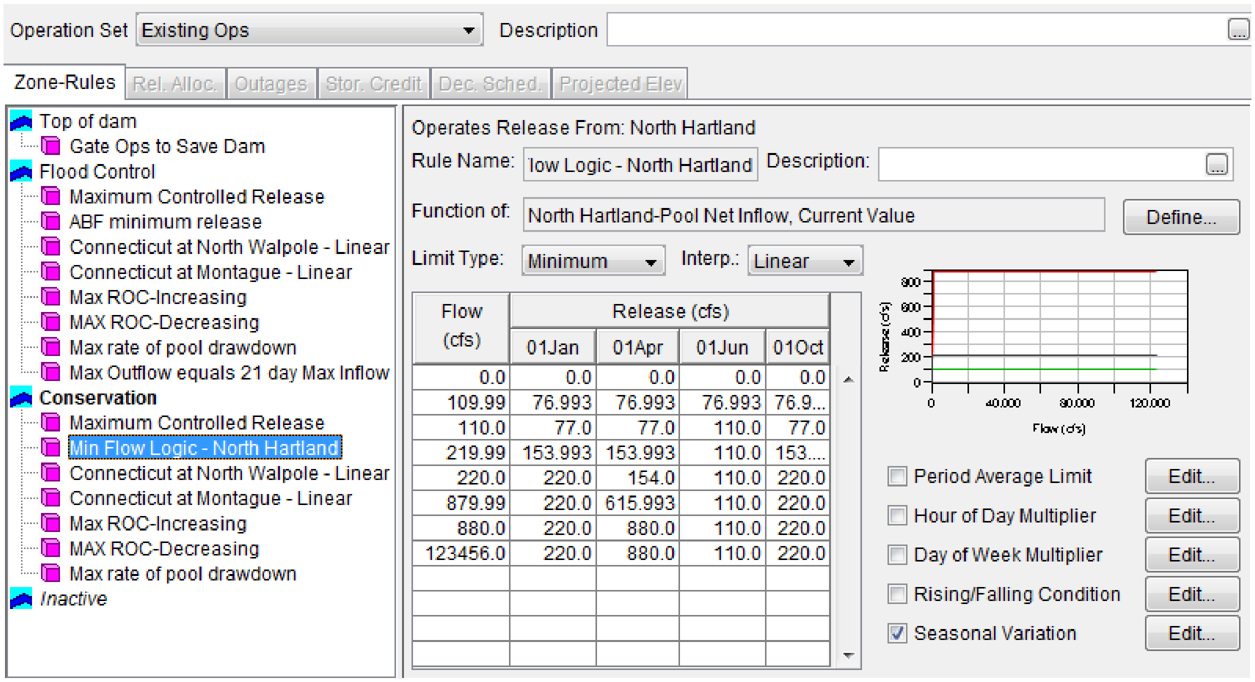


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet –Min Flow Logic-North Hartland

North Springfield

I. Overview

North Springfield is a dam on the Black River in Central Vermont. It was constructed in 1960 by the US Army Corps of Engineers and is still owned and operated by the Corps. It is primarily used for flood control purposes but also for recreation.

Figure 1 shows the location of North Springfield Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the dam.

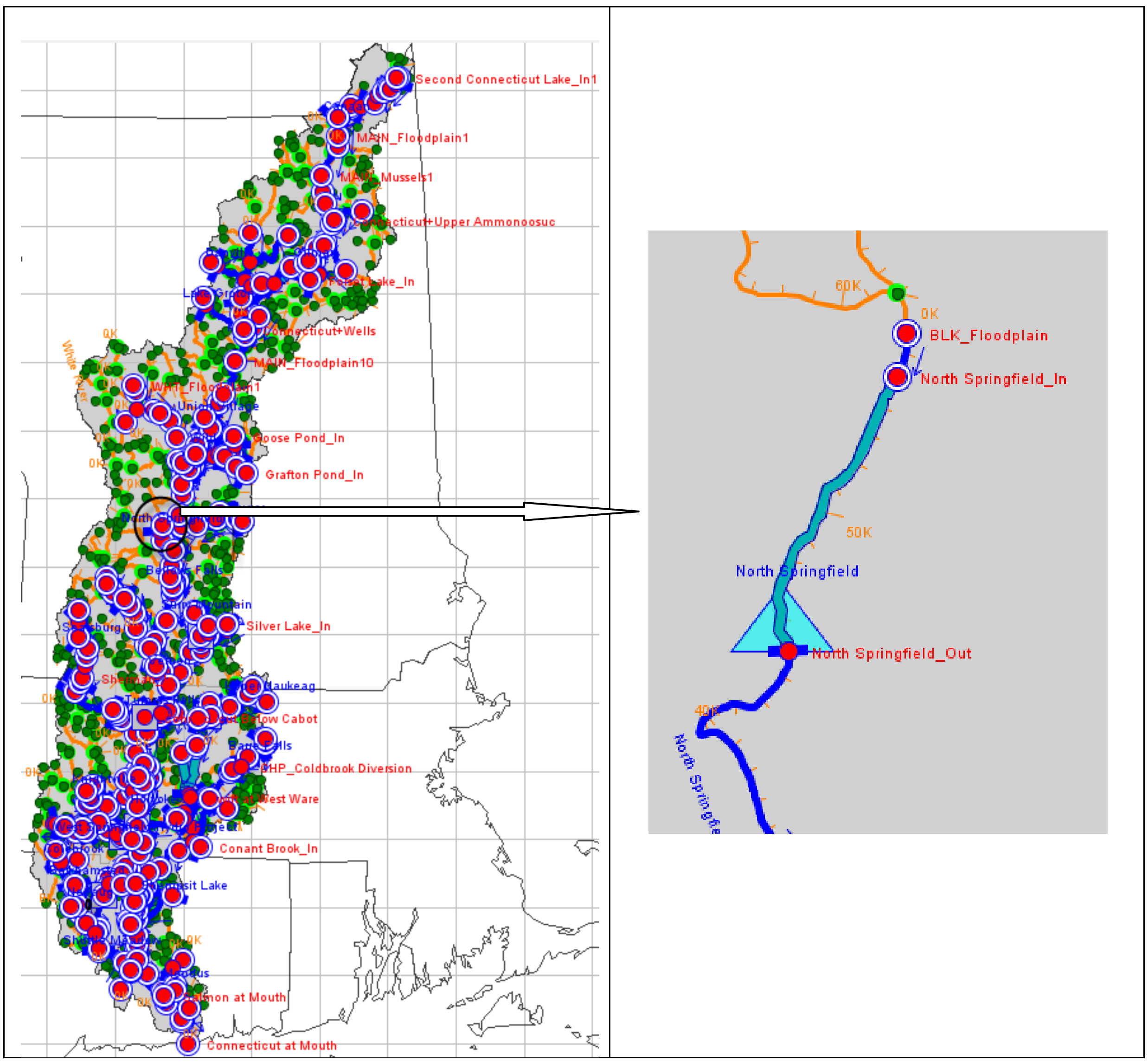


Figure 1: HEC-ResSim Map Display Showing Location of North Springfield dam

Figure 2: Photo of North Springfield dam.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled slide gates, and (2) uncontrolled spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[75].

[75] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

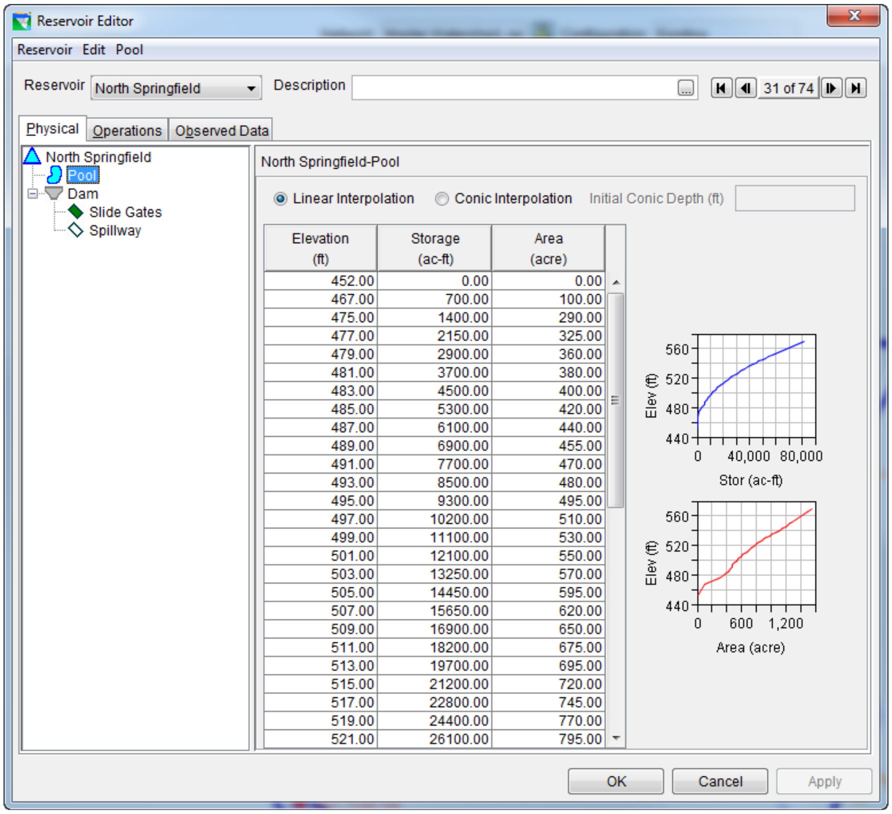


Figure 3: Reservoir Editor: Physical Tab -- Pool

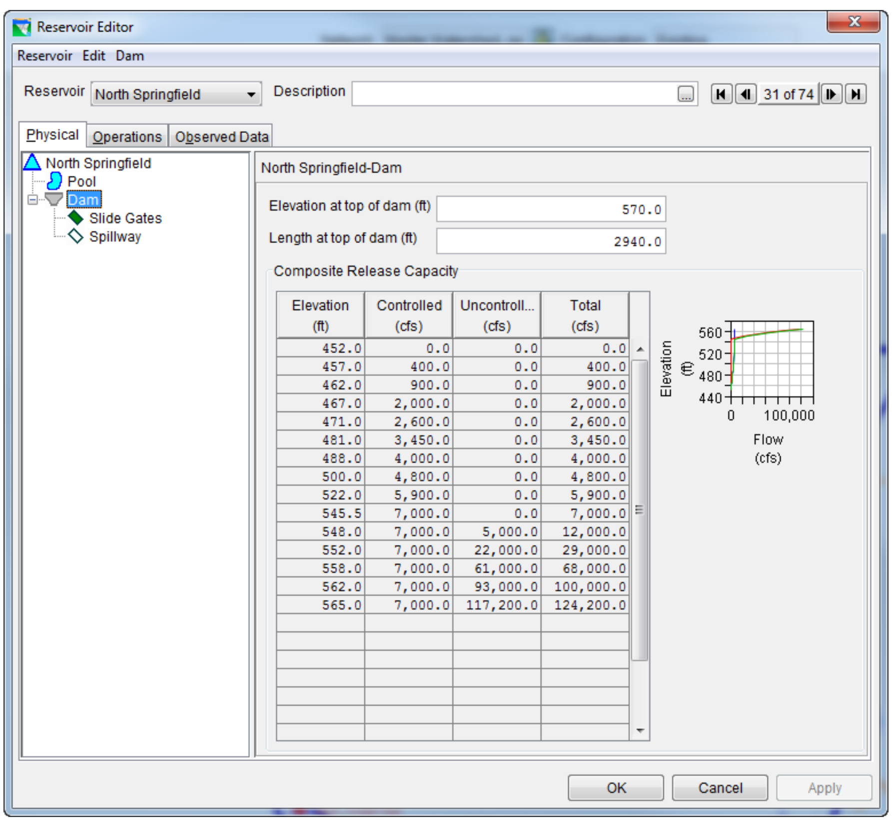


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of North Springfield's "ExistingOps" operational zones, which consist of zones of Top of dam (570 ft), Flood Control (545.5 ft), Conservation (467 ft), and Inactive zone (452 ft).

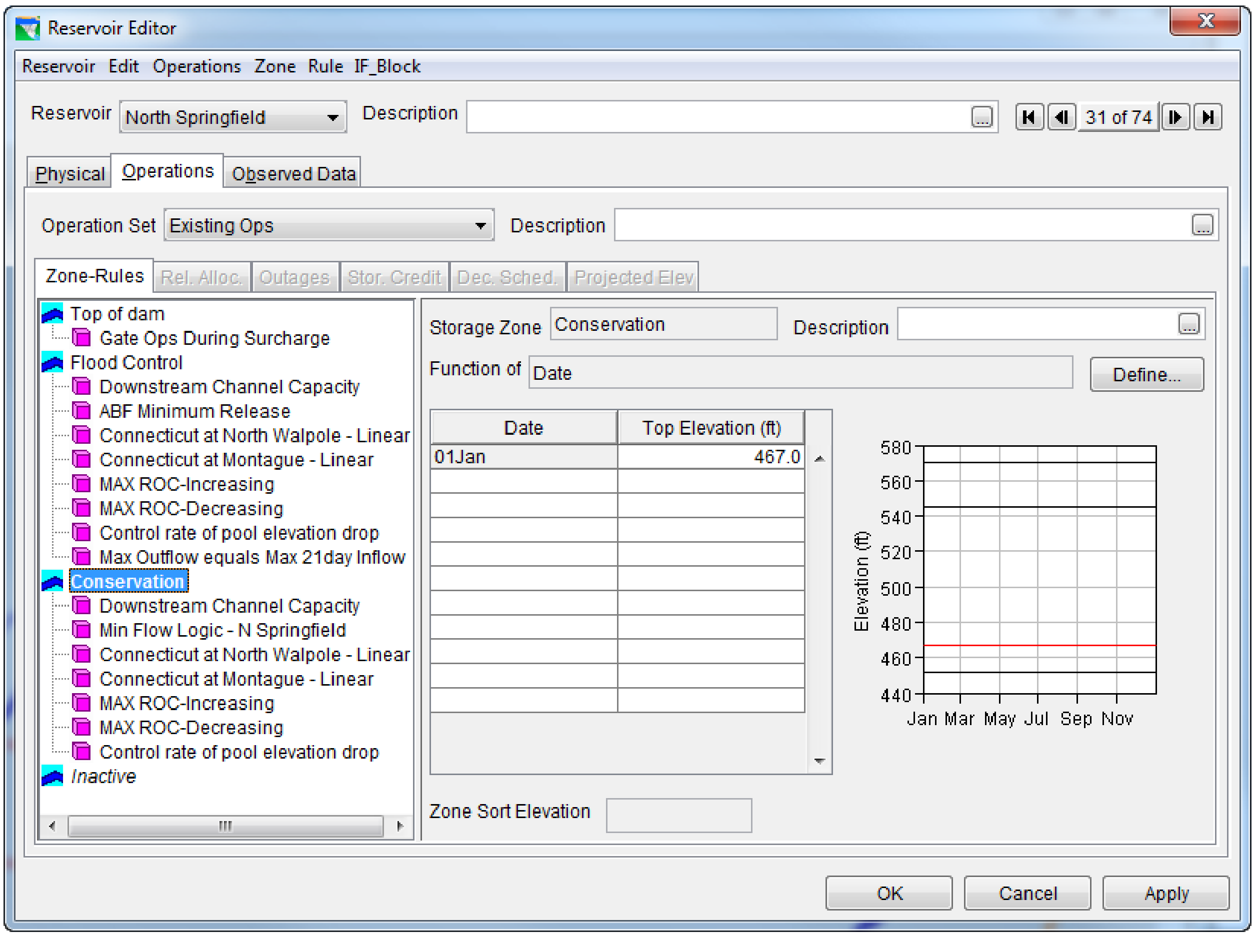


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

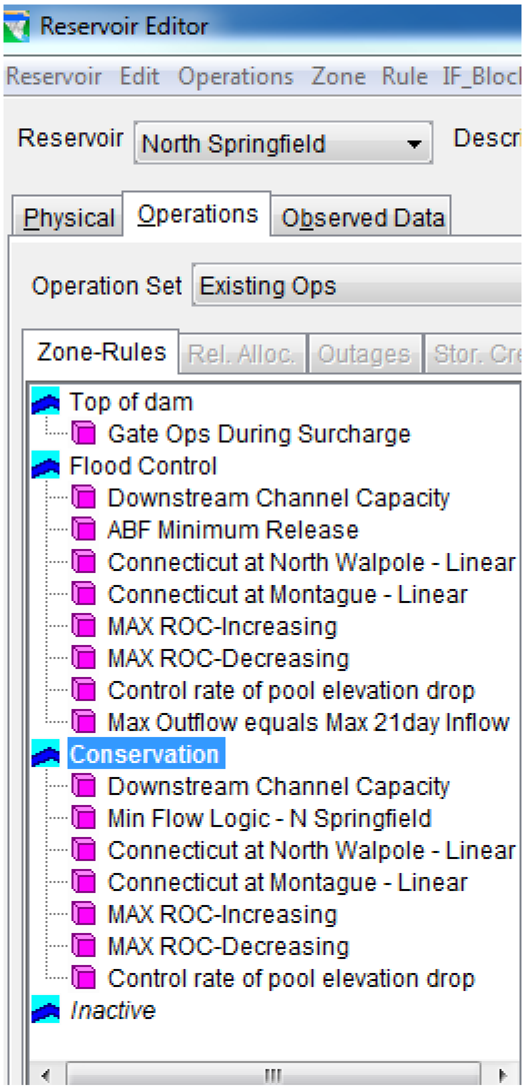


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Gate Ops During Surcharge

Figure 7 shows the content of "Gate Ops During Surcharge" rule. This rule represents the maximum allowable release from Slide gates as a function of pool elevation when the pool is in Top of dam zone.

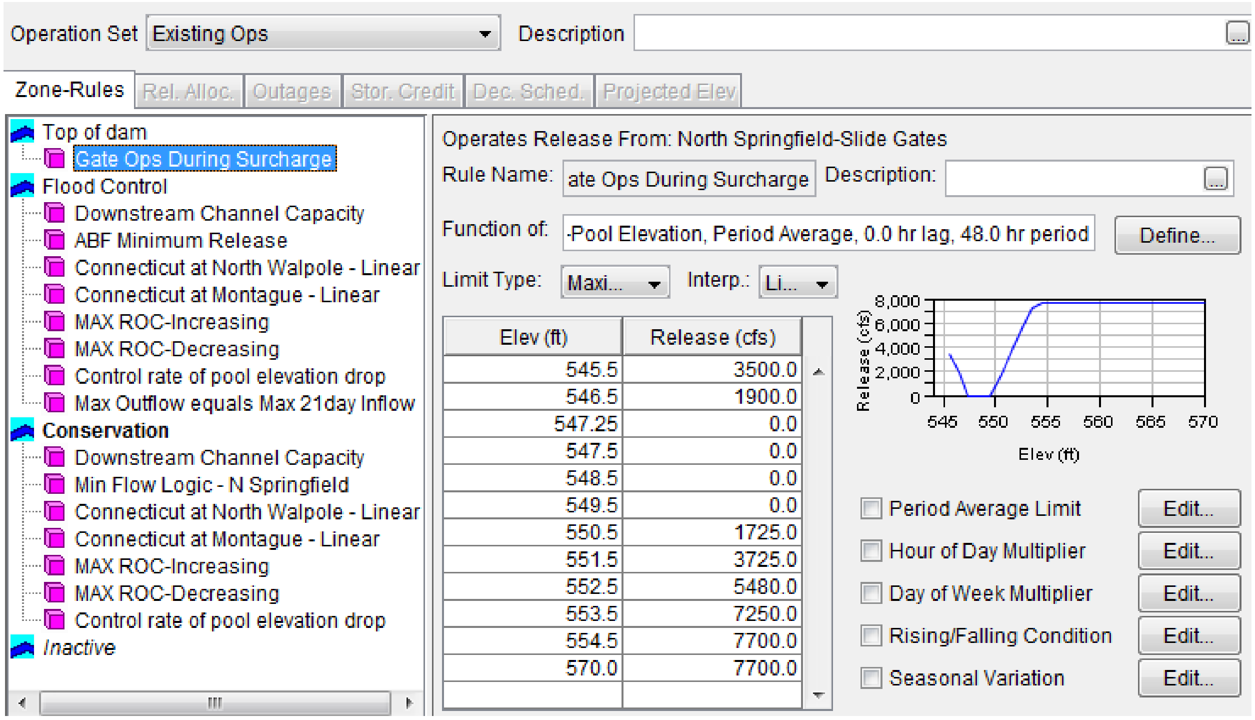


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Gate Ops During Surcharge

2. *Downstream Channel Capacity*

Figure 8 shows the content of "Downstream Channel Capacity" rule. This rule represents the maximum allowable release from dam.

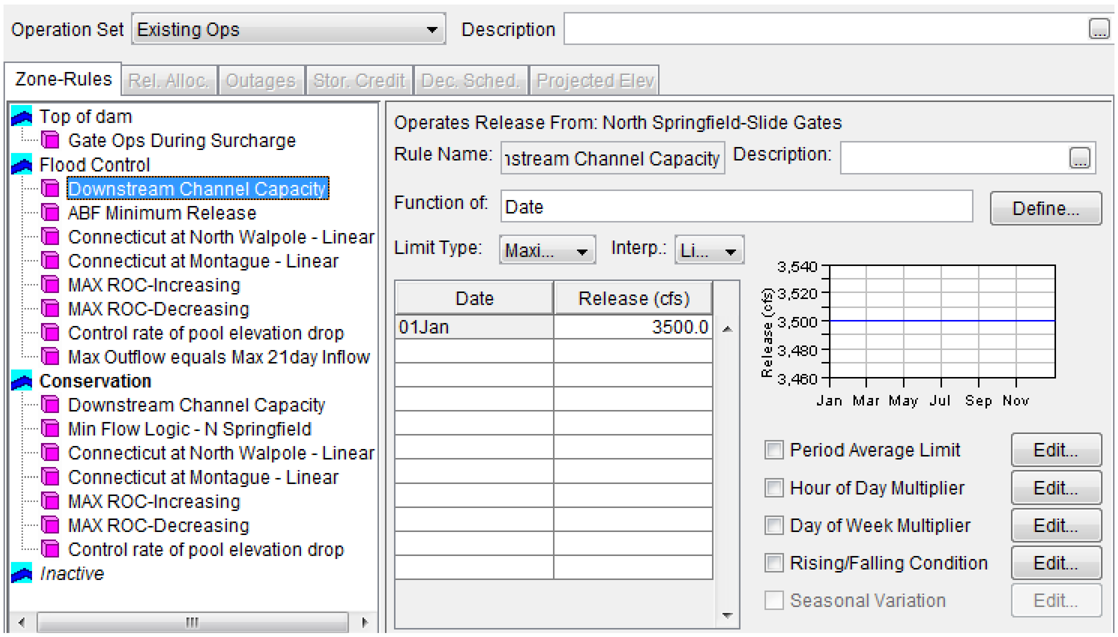


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Downstream Channel capacity

3. *ABF Minimum Release*

Figure 9 shows the content of "ABF Minimum Release" rule. This rule represents the minimum required release from slide gates during flood control operations.

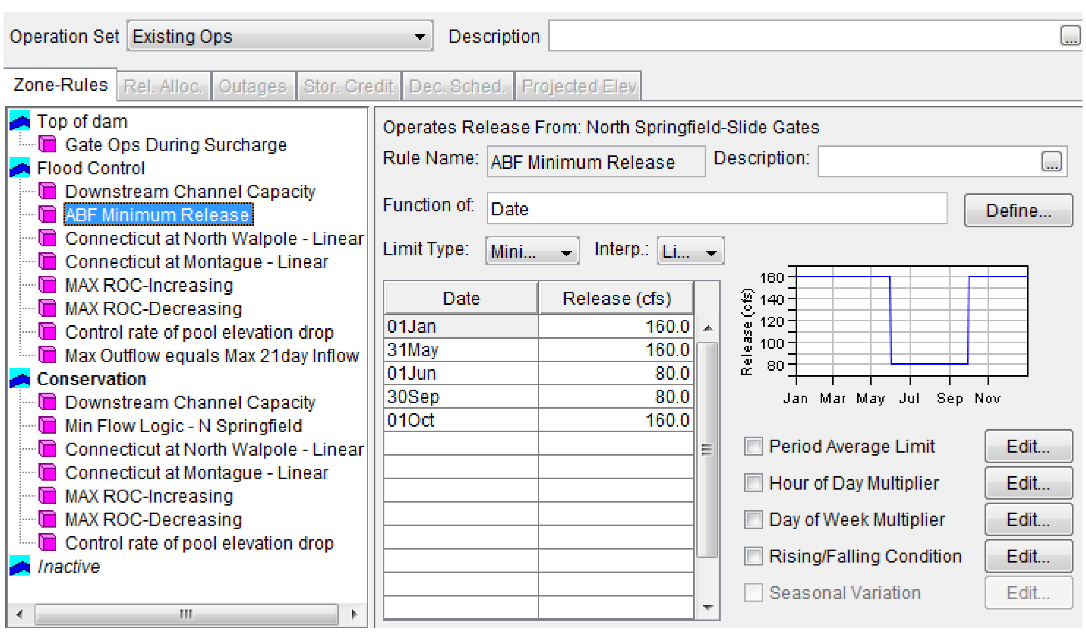
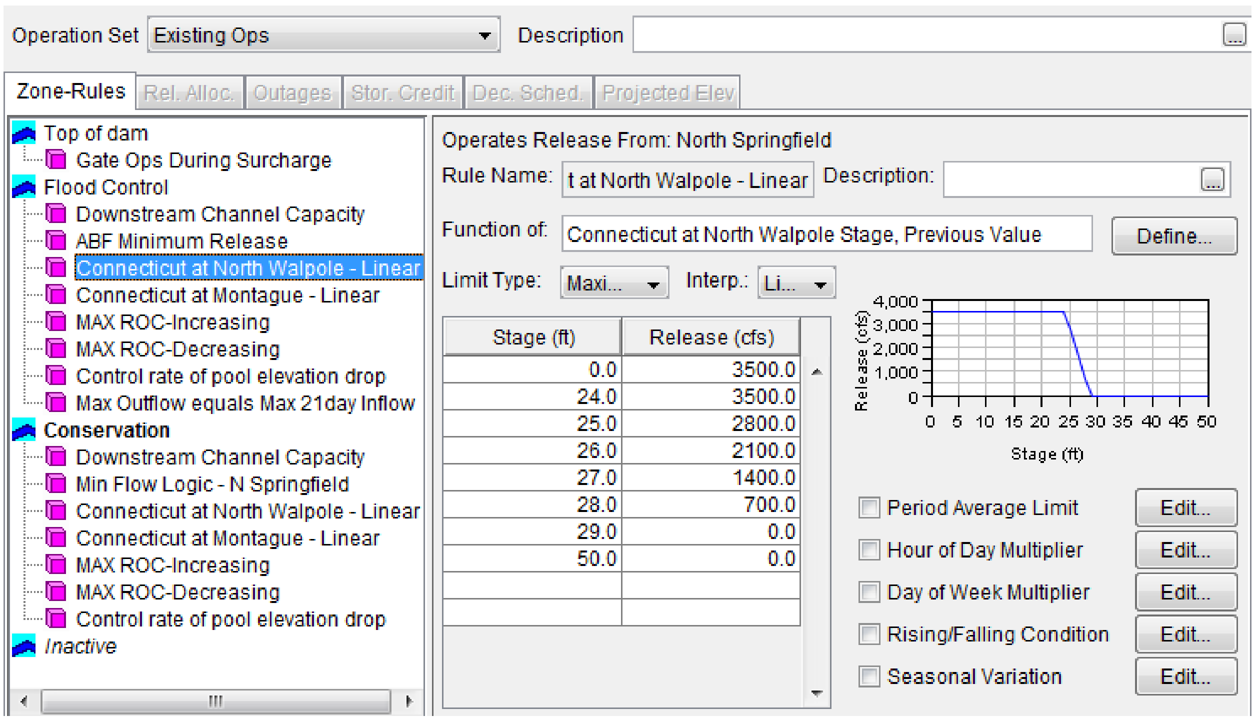


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – ABF Minimum Release

4. Connecticut at North Walpole-Linear

Figure 10 shows the content of "Connecticut at North Walpole-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at North Walpole. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.



Stage (ft)	Release (cfs)
0.0	3500.0
24.0	3500.0
25.0	2800.0
26.0	2100.0
27.0	1400.0
28.0	700.0
29.0	0.0
50.0	0.0

Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at North Walpole-Linear

5. Connecticut at Montague-Linear

Figure 11 shows the content of "Connecticut at Montague-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montague. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

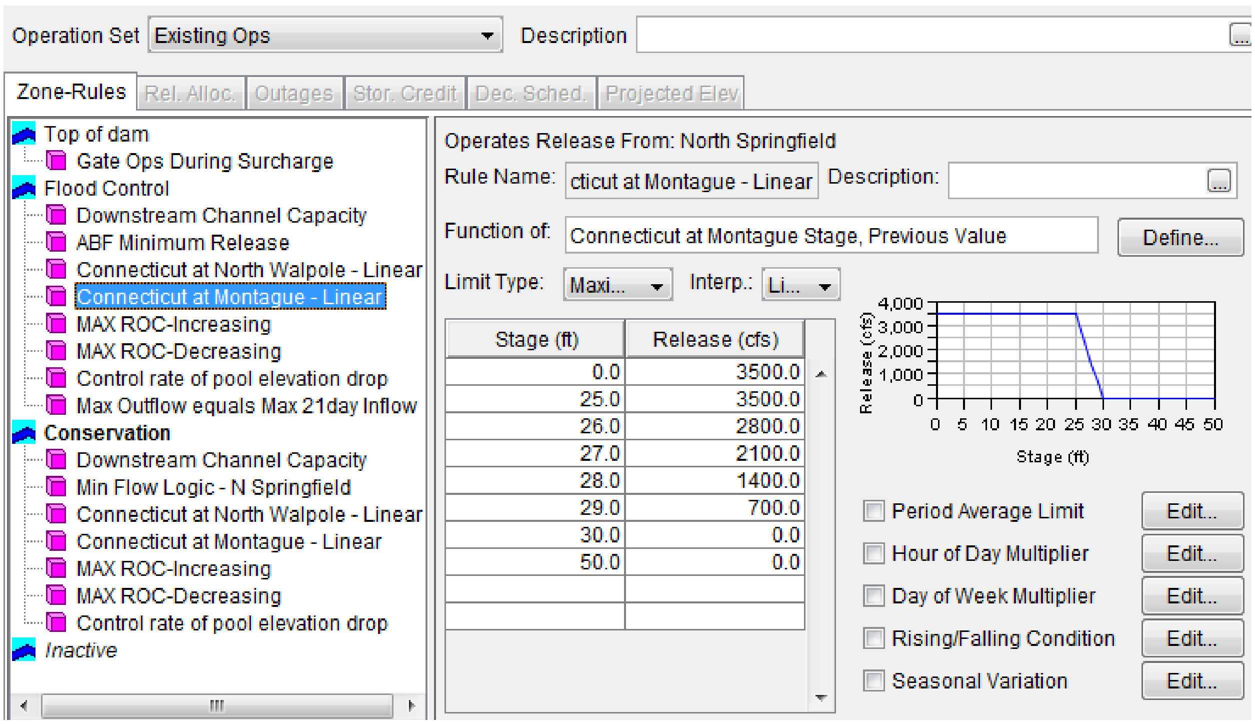


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague-Linear

6. MAX ROC-Increasing

Figure 12 shows the content of "MAX ROC-Increasing" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from North Springfield dam.

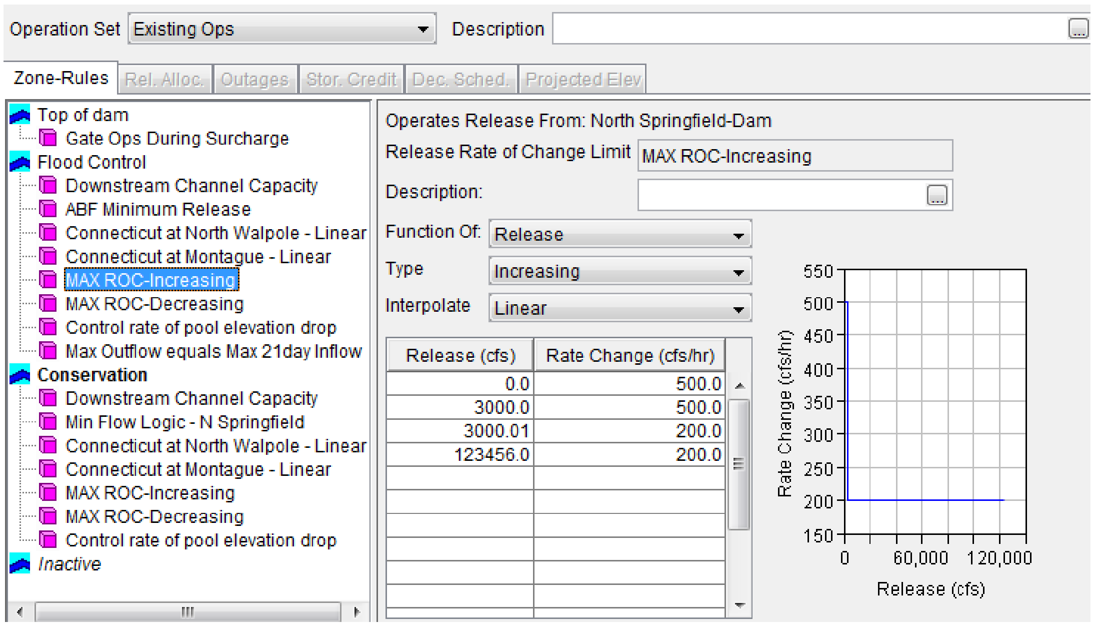


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – MAX ROC-Increasing

7. MAX ROC-Decreasing

Figure 13 shows the content of "MAX ROC-Decreasing" rule. This rule shows the maximum allowable decreasing release rate of change.

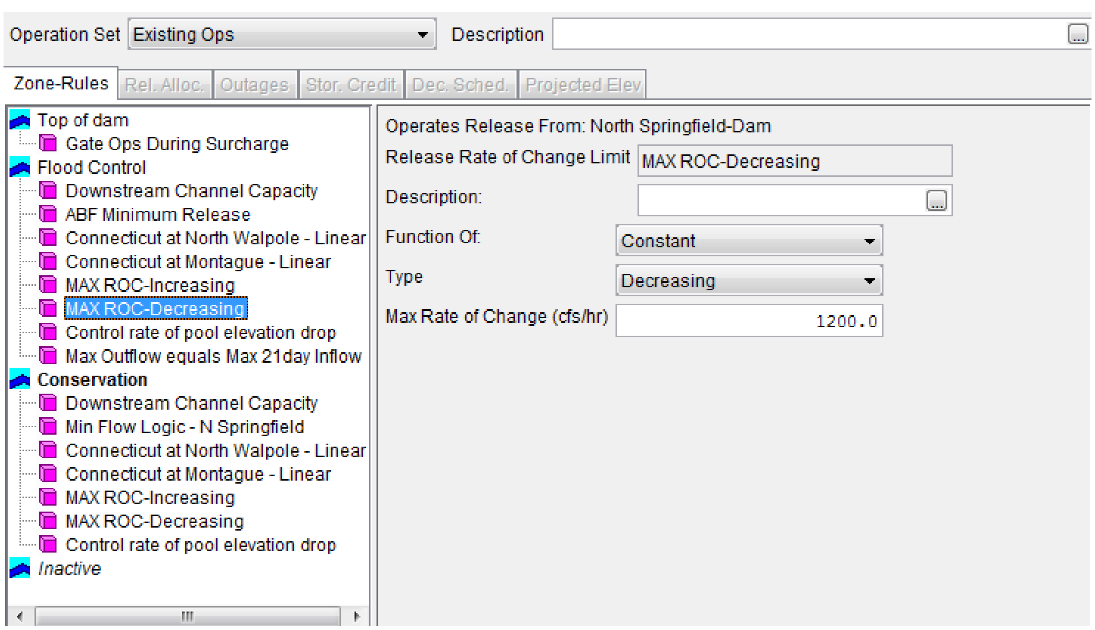


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – MAX ROC-Decreasing

8. *Control rate of pool elevation drop*

Figure 14 shows the content of "Control rate of pool elevation drop" rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

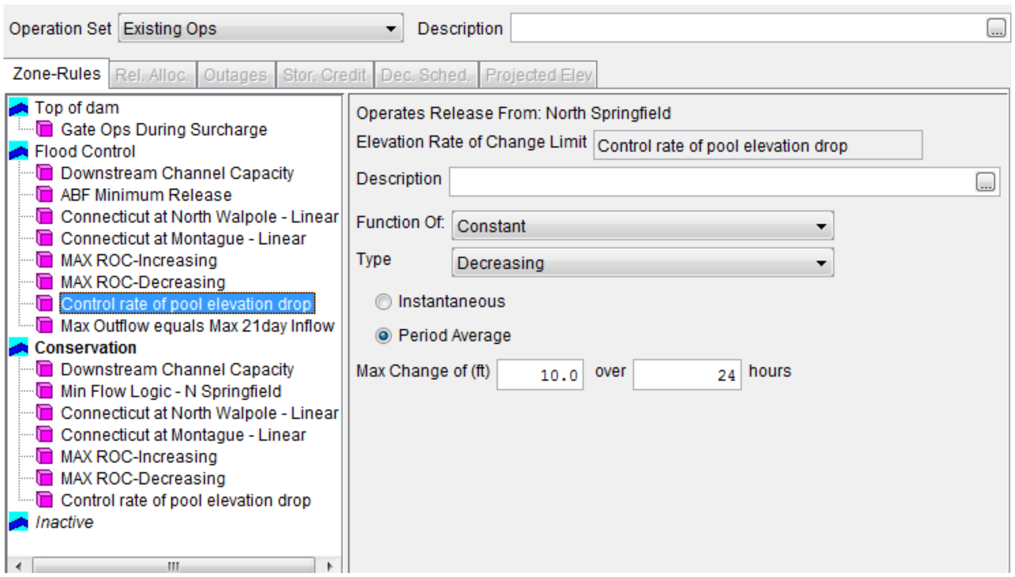


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet – Control rate of pool elevation drop

9. *Max Outflow equals Max 21 day Inflow*

Figure 15 shows the content of "Max outflow equals Max 21 day Inflow" rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

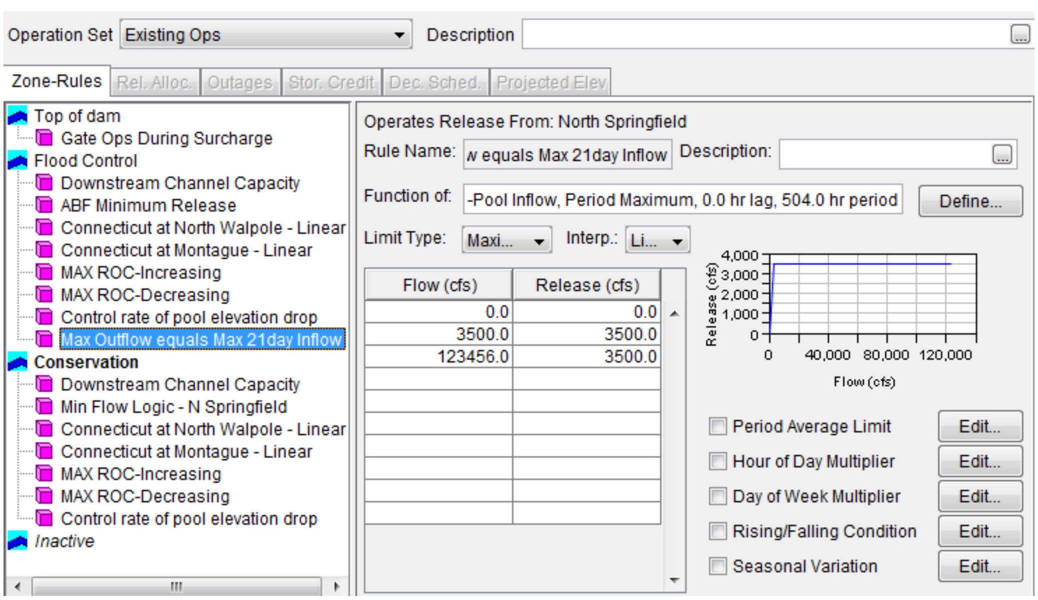


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals Max 21 day Inflow

10. Min Flow Logic-N Springfield

Figure 16 shows the content of "Min Flow Logic-N Springfield" rule. This rule describes required seasonal minimum flows from controlled outlets as a function of inflow at North Springfield.

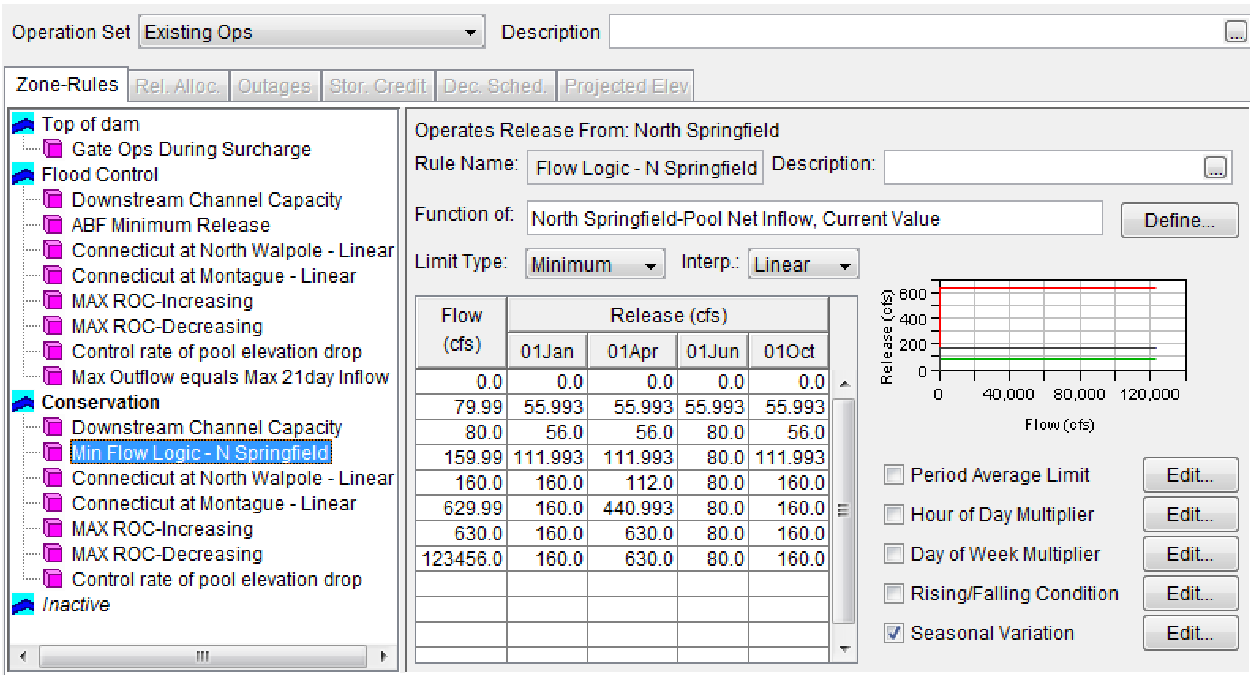


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic-N Springfield

Northfield

I. Overview

Northfield (full name Northfield Mountain) is a pump storage project located on the mainstem Connecticut River above Turners Falls. It is owned and operated by FirstLight Power Resource and is operated for hydropower generation in connection with the Turners Falls project, another FirstLight Power resources project.

Figure 1 shows the location of Northfield Mountain dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the Northfield Mountain project.

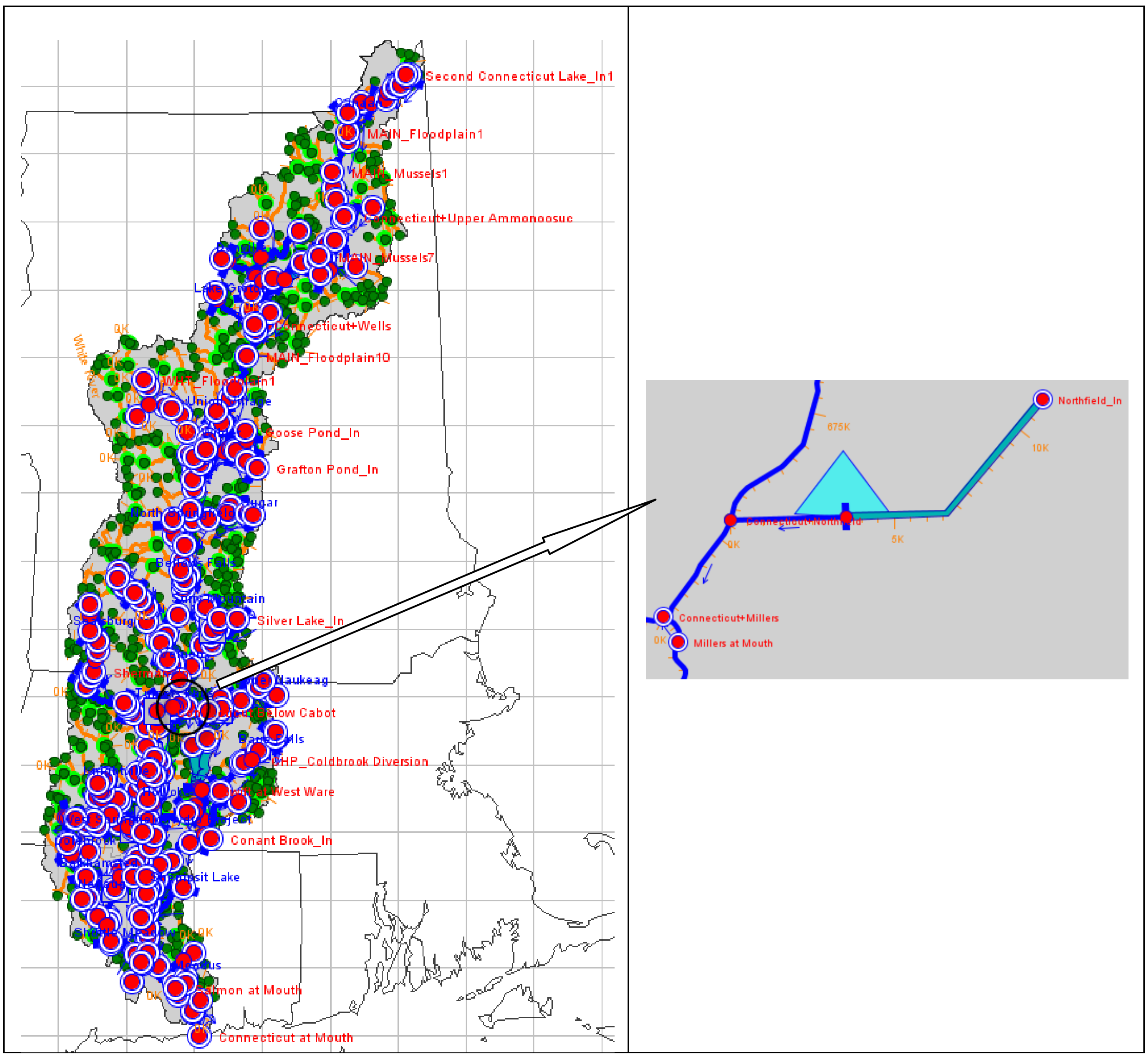


Figure 1: HEC-ResSim Map Display Showing Location of Northfield dam

Figure 2: Photo of Northfield Mountain project

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[76]. The dam consists of two types of outlets: (1) pump, and (2) Northfield Station, as shown in Figure 4.

[76] All physical and operational data from ResSim model developed by Gomez and Sullivan Engineers, P.C.

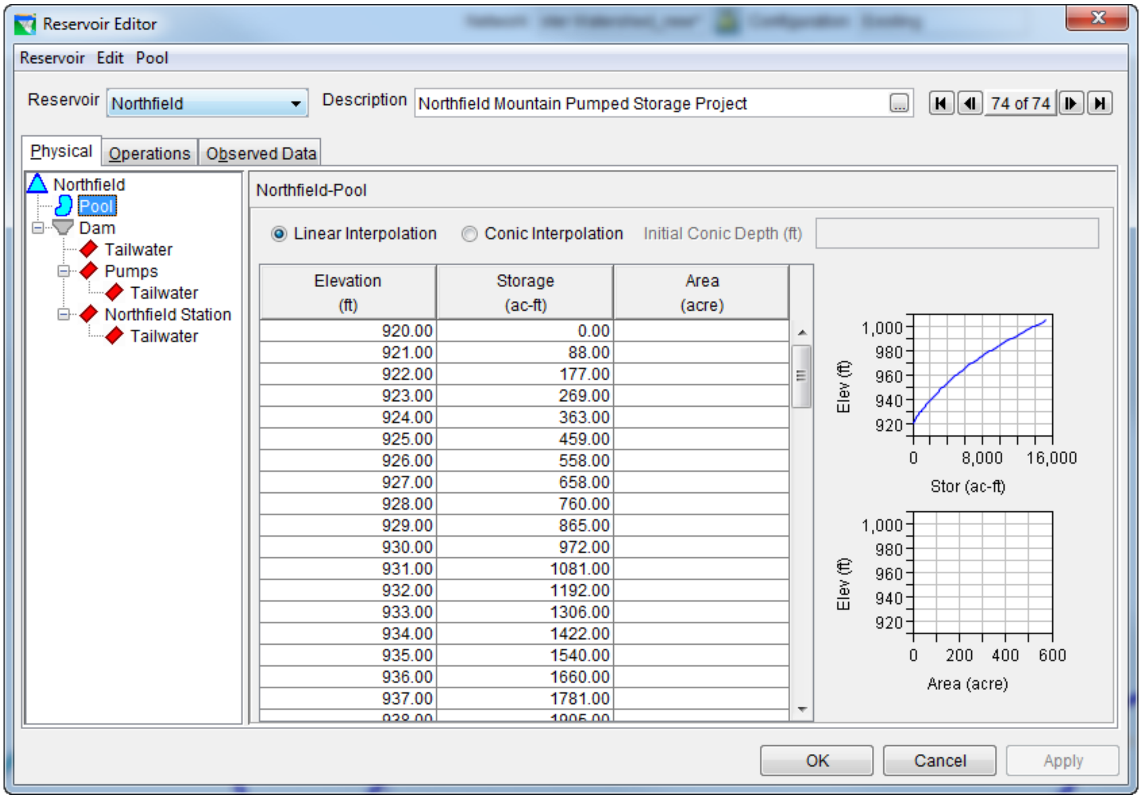


Figure 3: Reservoir Editor: Physical Tab -- Pool

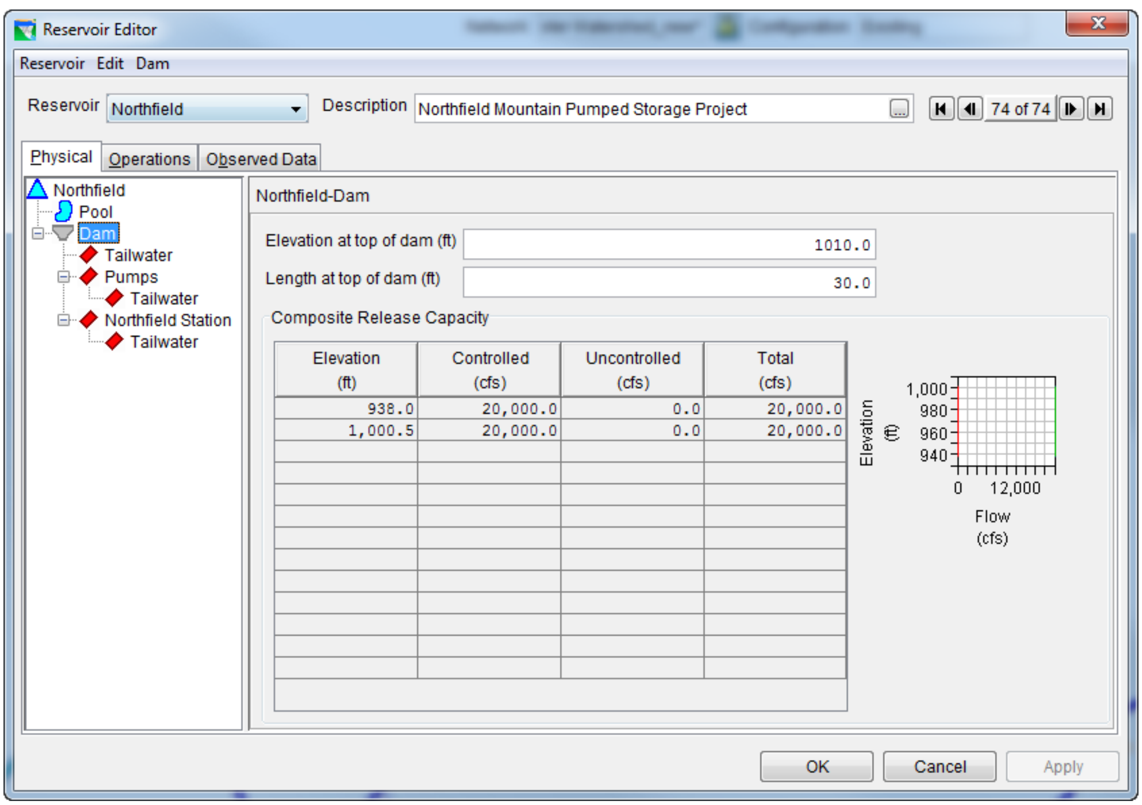


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Northfield's "ExistingOps" operational zones, which consist of zones of Flood Control (1010 ft), FERC Max Pool (100.5 ft), and Inactive zone (938 ft)[1].

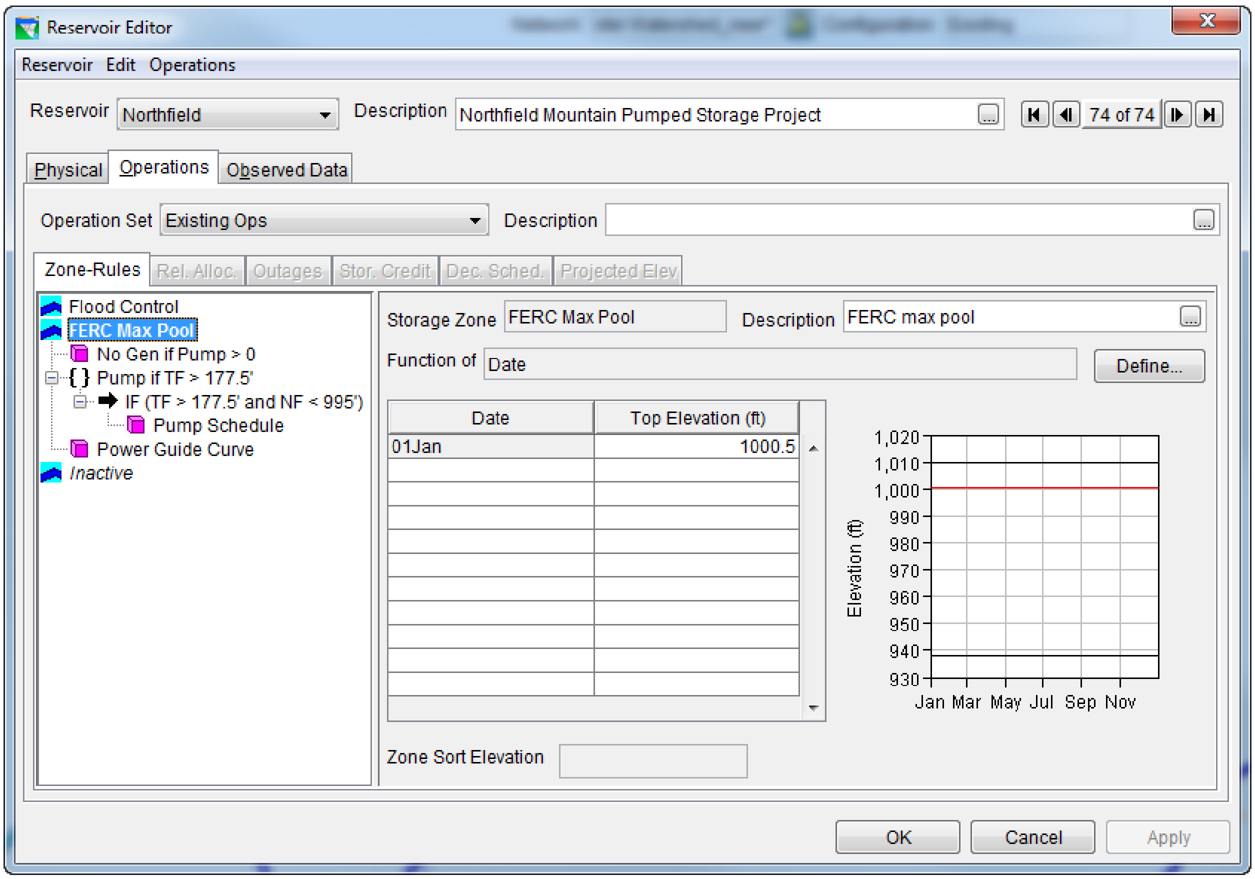


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[1].

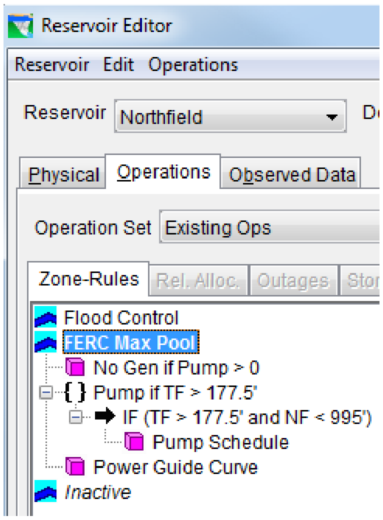


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. No Gen if Pump>0

Figure 7 shows the content of "No Gen if Pump>0" rule. This rule represents that when water is pumped then no water is released from Northfield.

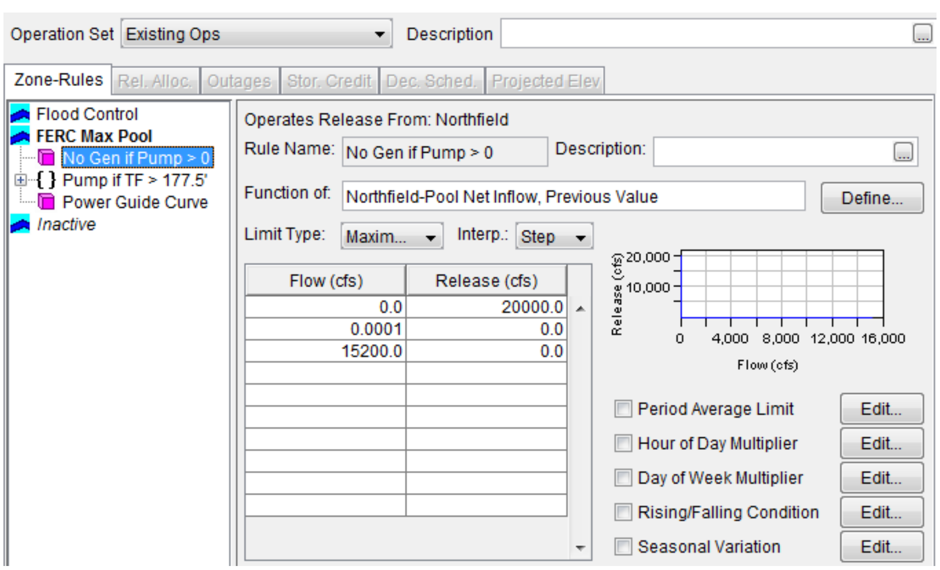
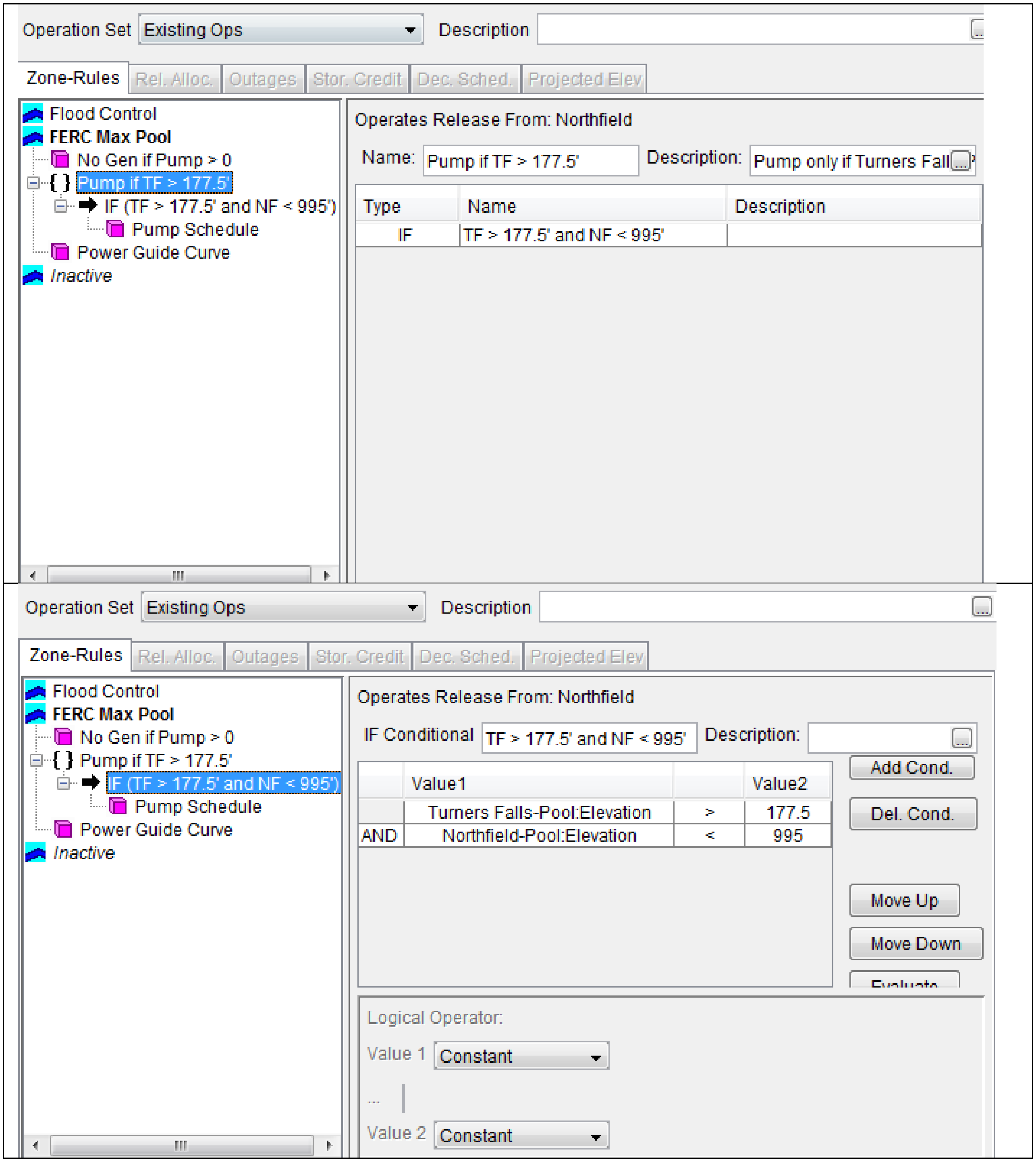


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – No Gen if Pump>0

2. *Pump if TF>177.5'*

Figure 8 shows the content of "Pump if TF>177.5" rule. This rule shows that if Turner falls pool elevation is less than 175' and Northfield pool elevation is less than 995'then water is pumped.



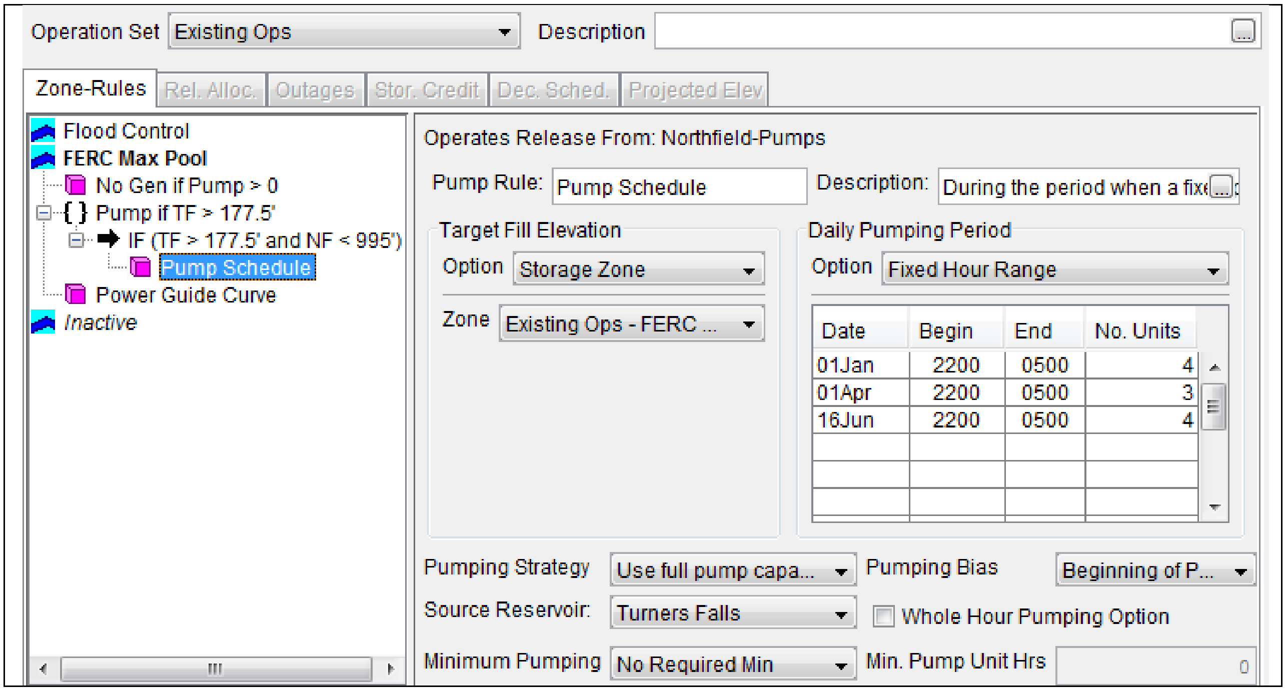


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet –Pump if TF>177.5'

3. *Power Guide Curve*

Figure 9 shows the content of "Power Guide Curve" rule. This rule shows the 9.6 hours of power generation in a day.

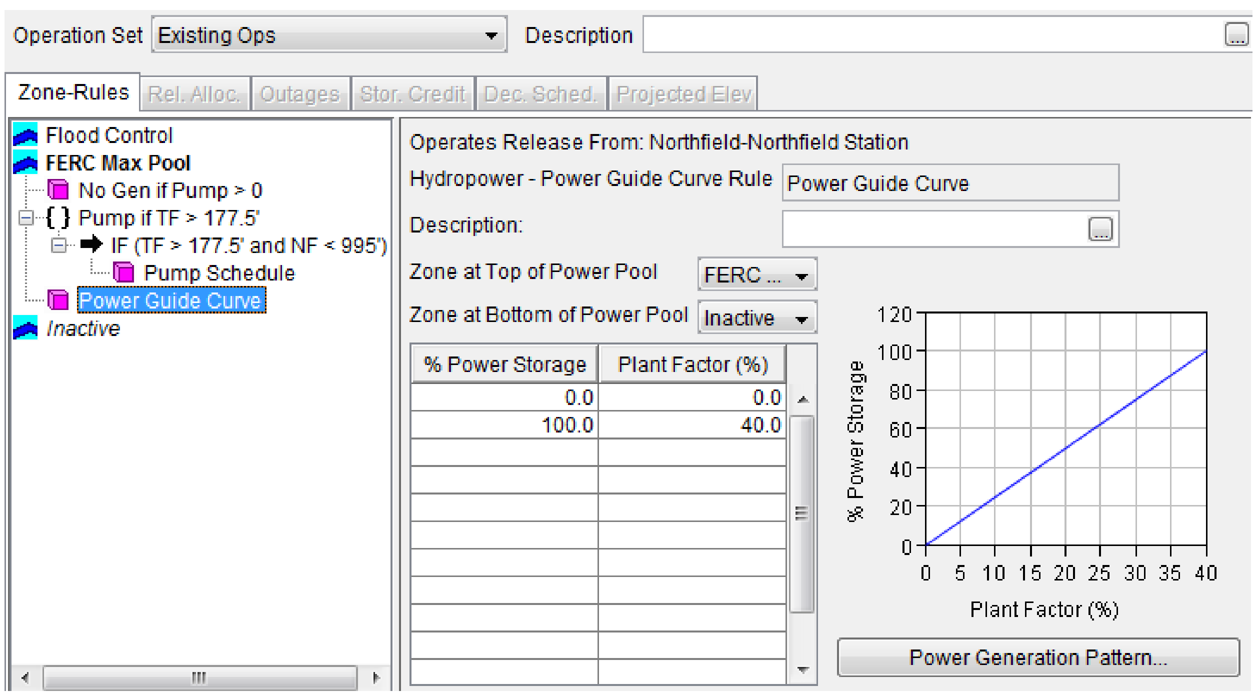


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Power Guide Curv

Otis

I. Overview

Otis dam is located in the towns of Otis and Tolland, MA on the west Branch of the Farmington River. It is owned and operated by the Massachusetts Department of Conservation and Recreation (DCR) and is used primarily for recreation.

Figure 1 shows the location of Otis dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Otis dam.

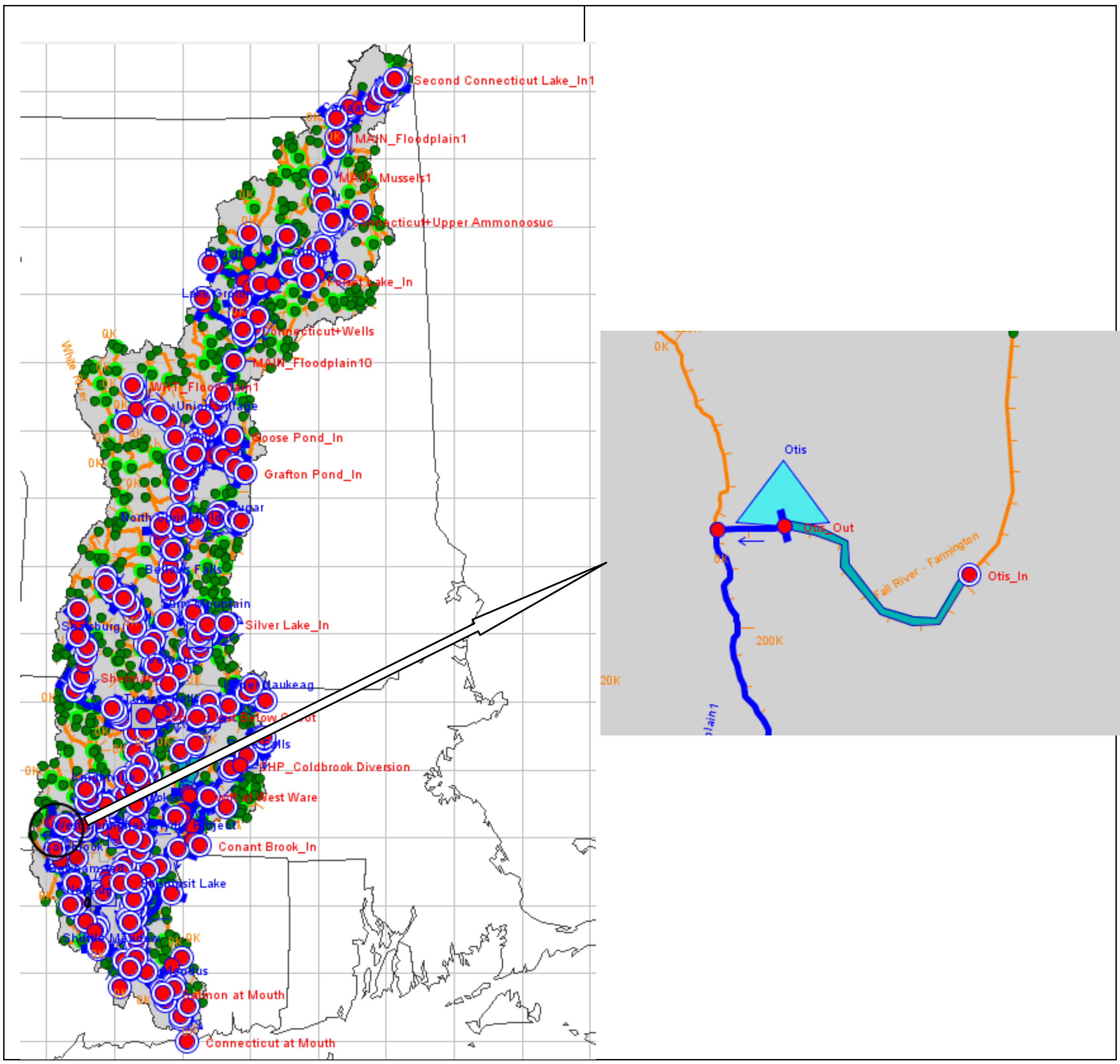


Figure 1: HEC-ResSim Map Display Showing Location of Otis dam

Figure 2: Photo of Otis dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[77]. The dam consists of two types of outlets: (1) controlled outlet, (2) uncontrolled spillway as shown in Figure 4.

[77] Data from UMASS

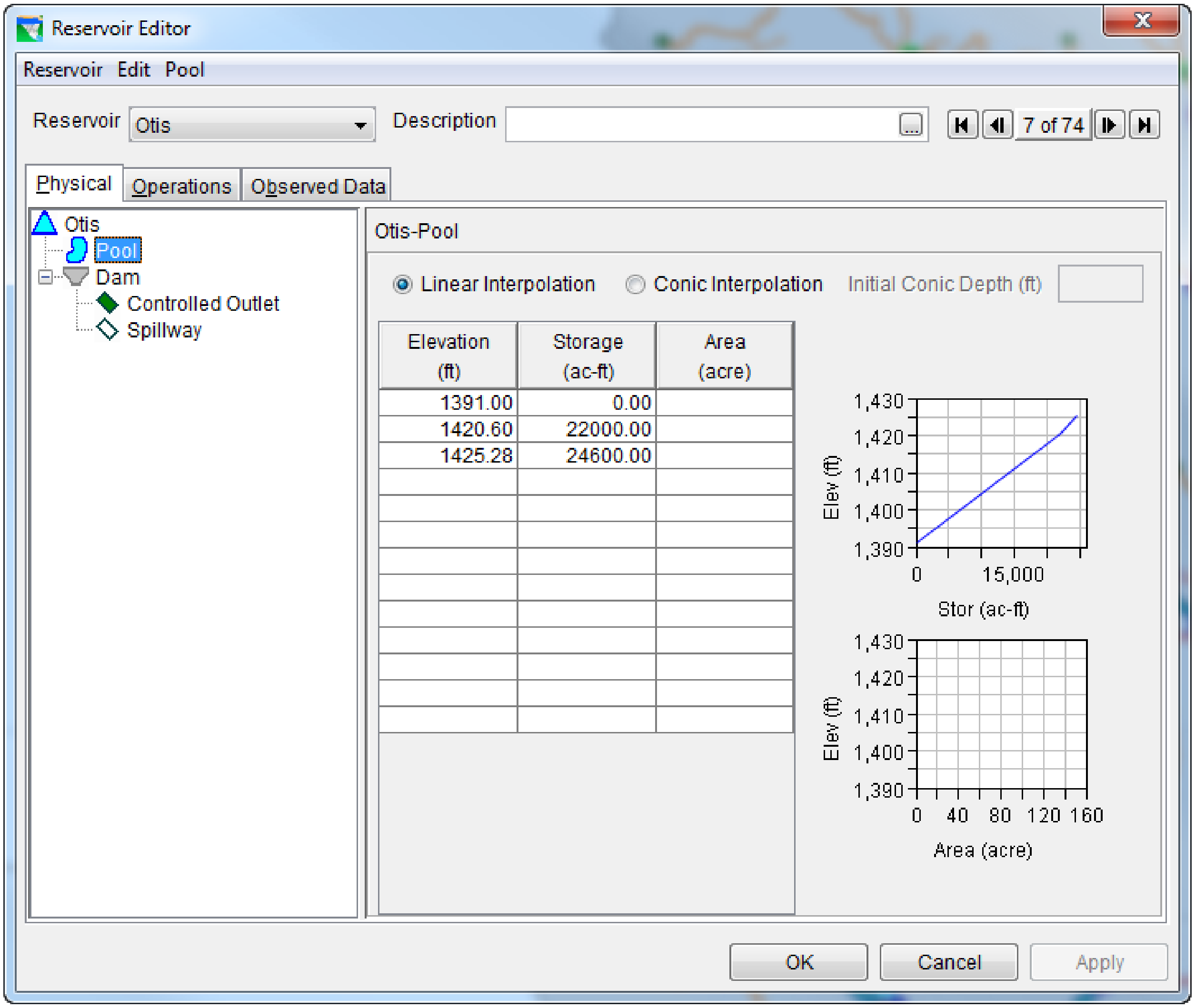


Figure 3: Reservoir Editor: Physical Tab -- Pool

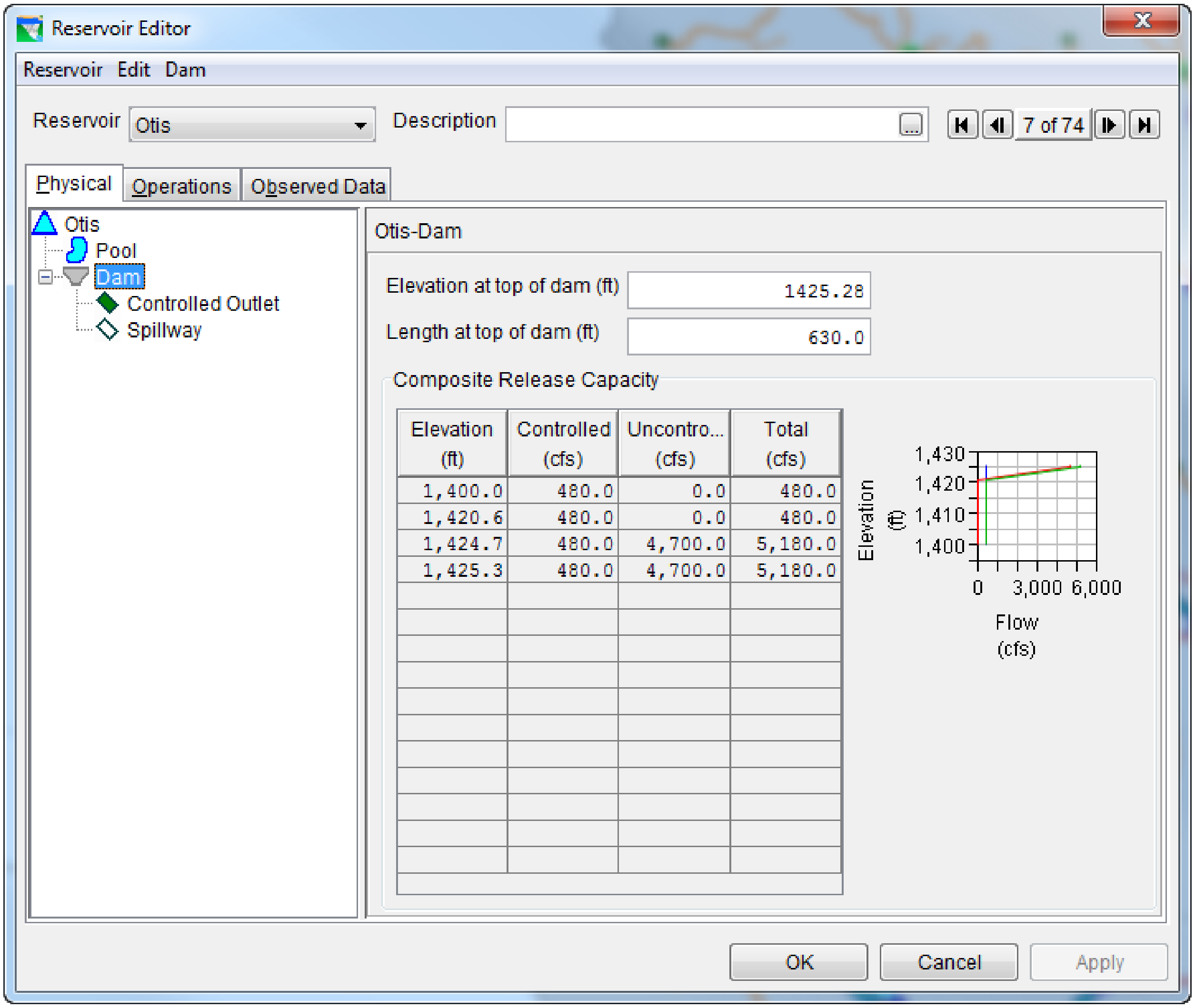


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Otis's "Existing Ops" operational zones, which consist of zones of Top of dam (1425.28 ft), conservation (1412.4-1420.6 ft), Min Pool, and Inactive zone (1400 ft)[1].

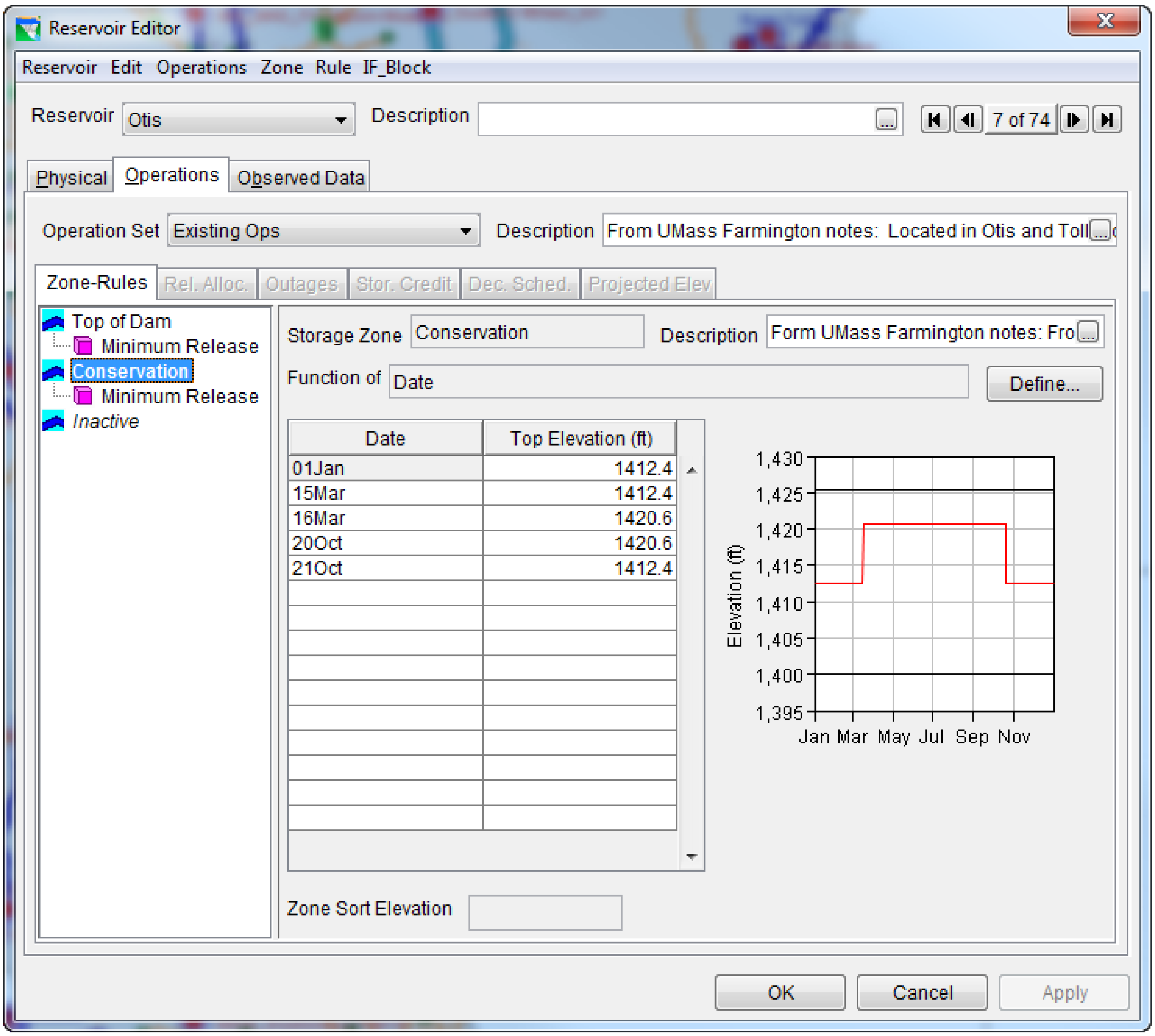


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops (Adamec, University of Massachuset,Amherst).

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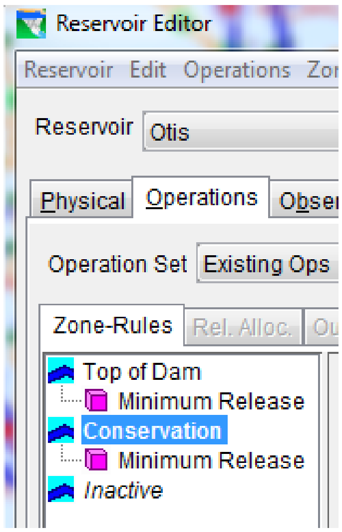


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Minimum Release

Figure 7 shows the content of "Minimum Release" rule. This rule represents a seasonal rule for minimum release from Otis reservoir.

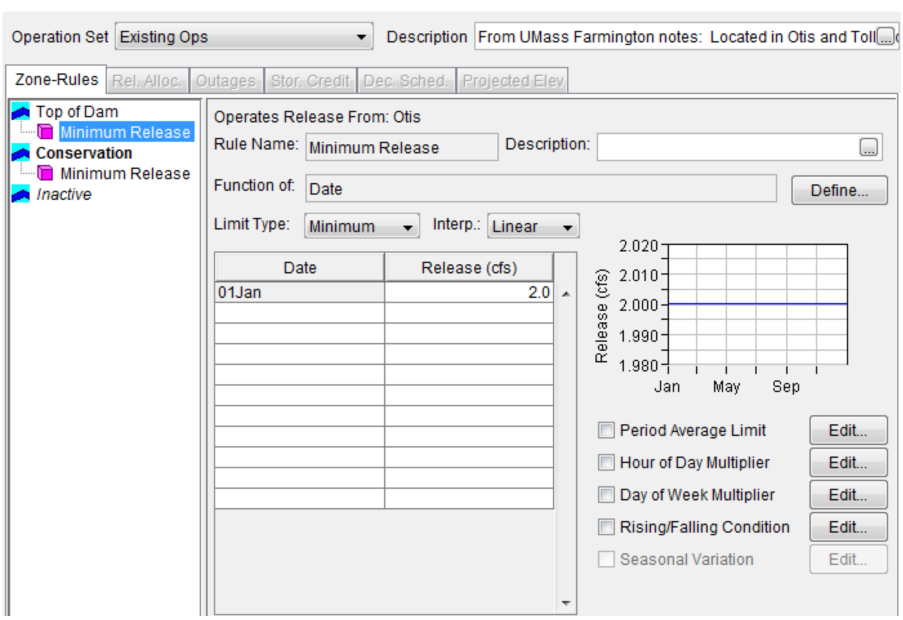


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Minimum Release

Otter Brook

I. Overview

Otter Brook dam is a dam on Otter Brook that flows into the Ashuelot River in New Hampshire. It was constructed in 1958 by the US Army Corps of Engineers and is still owned and operated by the Corps. It is primarily used for flood control but also for recreation.

Figure 1 shows the location of Otter Brook Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from Otter Brook dam.

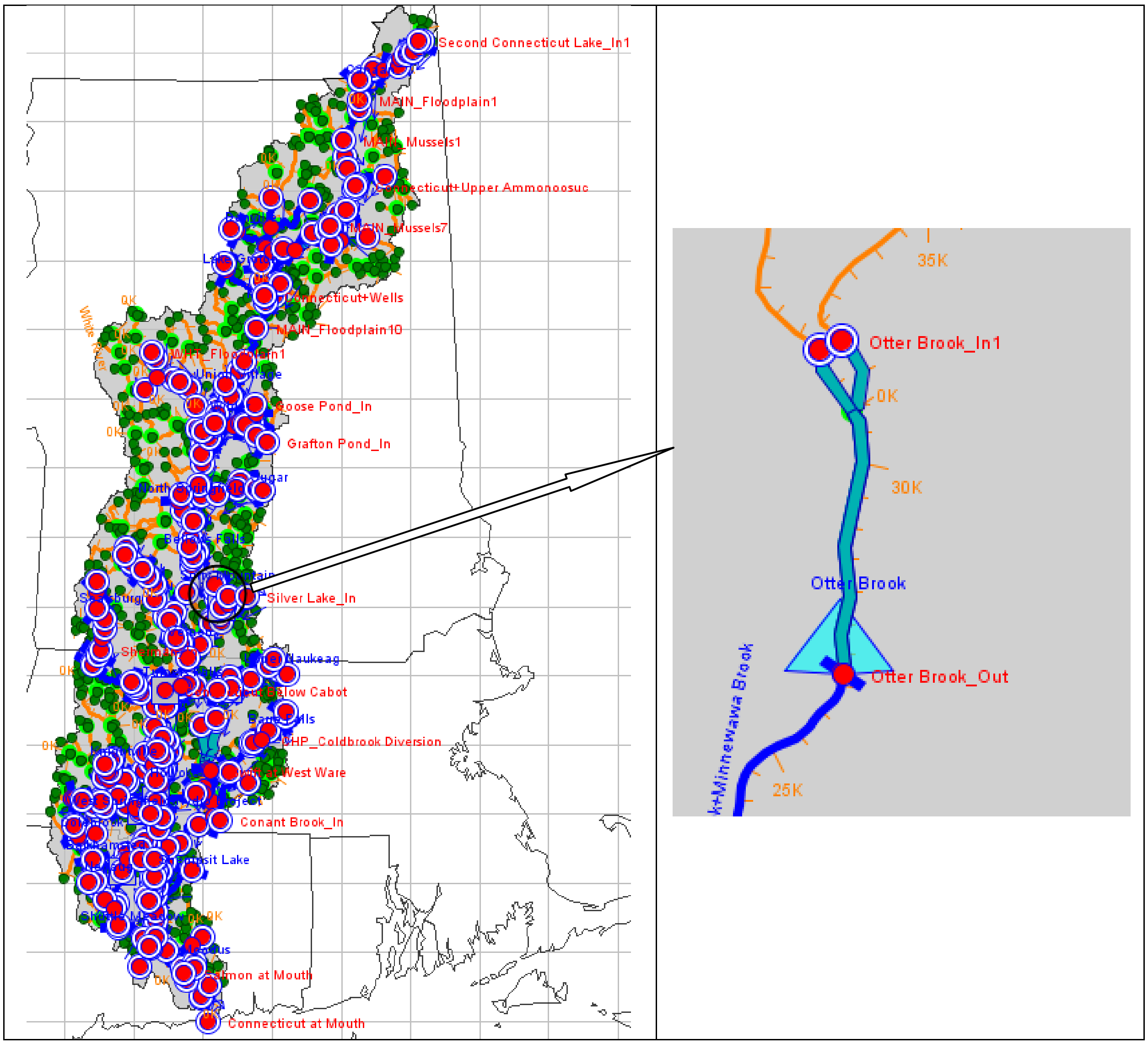


Figure 1: HEC-ResSim Map Display Showing Location of Otter Brook dam

Figure 2: Photo of Otter Brook Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled slide gates, and (2) uncontrolled spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[78].

[78] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

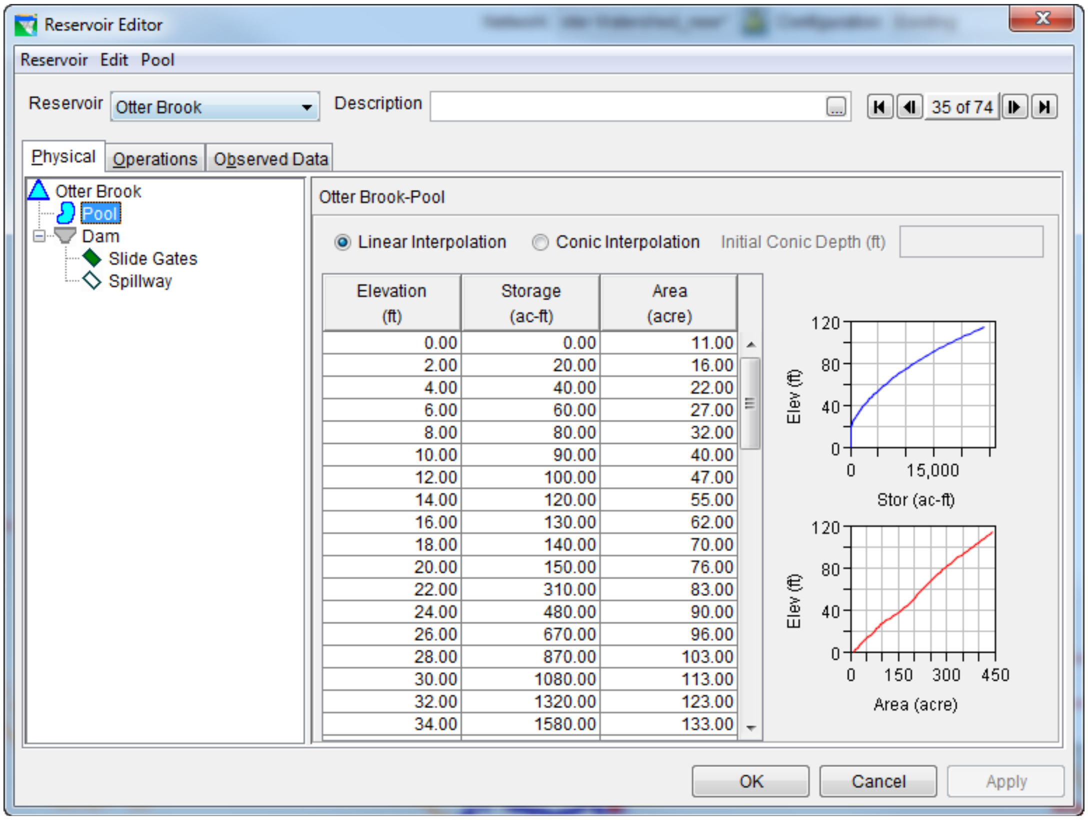


Figure 3: Reservoir Editor: Physical Tab -- Pool

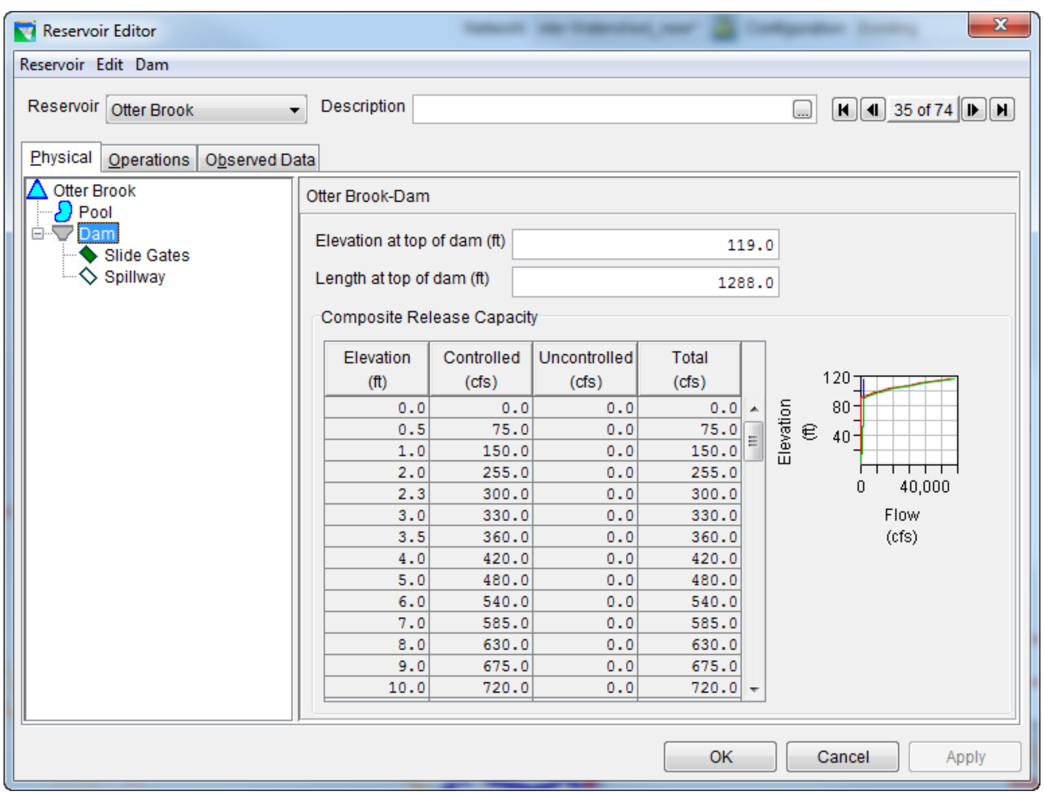


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Otter Brook's "ExistingOps" operational zones, which consist of zones of Surcharge-near TOD (119 ft), Surcharge (109 ft), Flood Control (89 ft), Conservation (20 ft), and Inactive zone (0 ft).

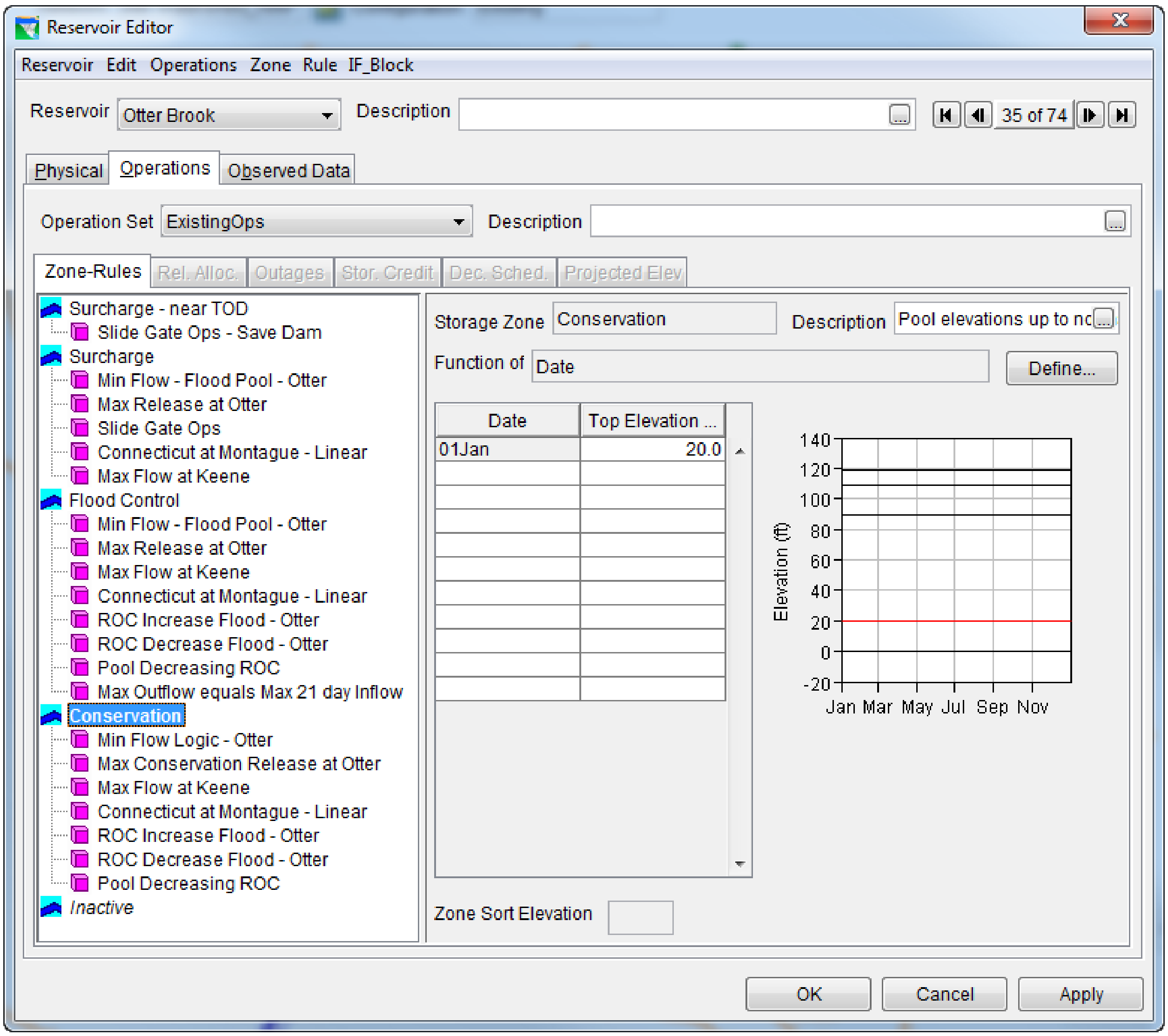


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

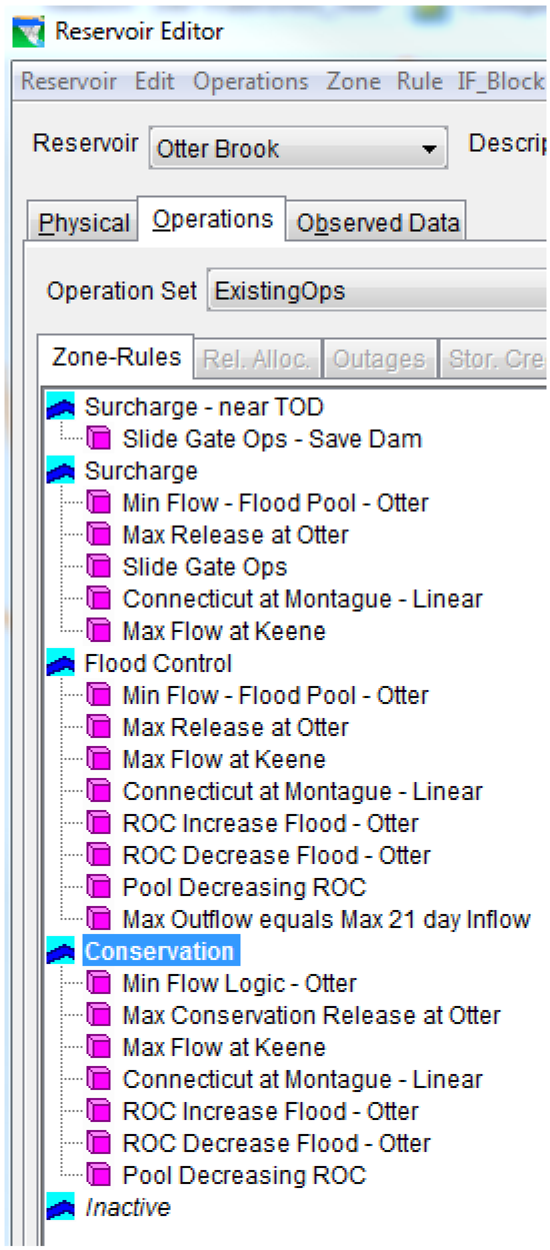


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Slide Gate Ops-Save Dam

Figure 7 shows the content of “Slide Gate Ops-Save Dam” rule. This rule represents the maximum allowable release from Slide gates as a function of pool elevation when the pool is in Surcharge-near TOD zone.

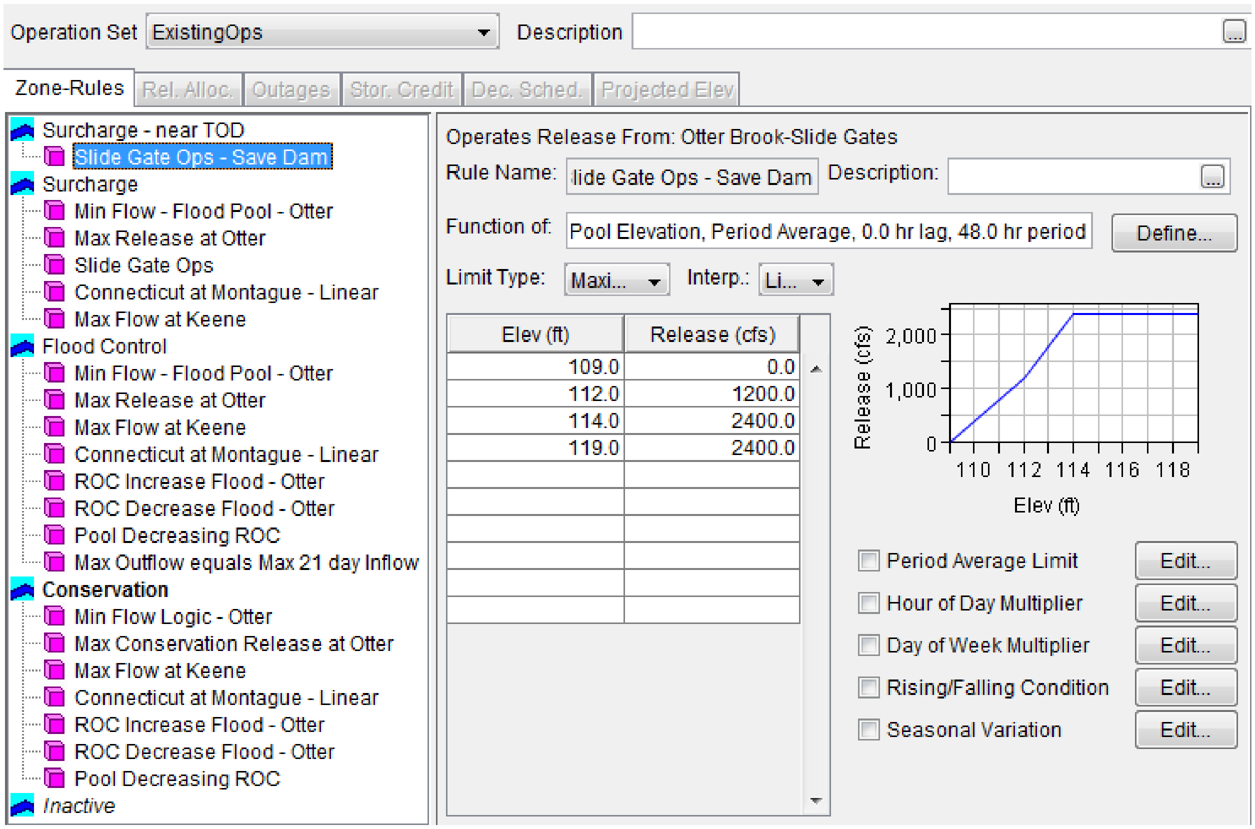


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Slide Gate Ops-Save Dam

2. *Min Flow-Flood Pool-Otter*

Figure 8 shows the content of “Min Flow-Flood Pool-Otter” rule. This rule shows the required minimum release from dam during flood control operations.

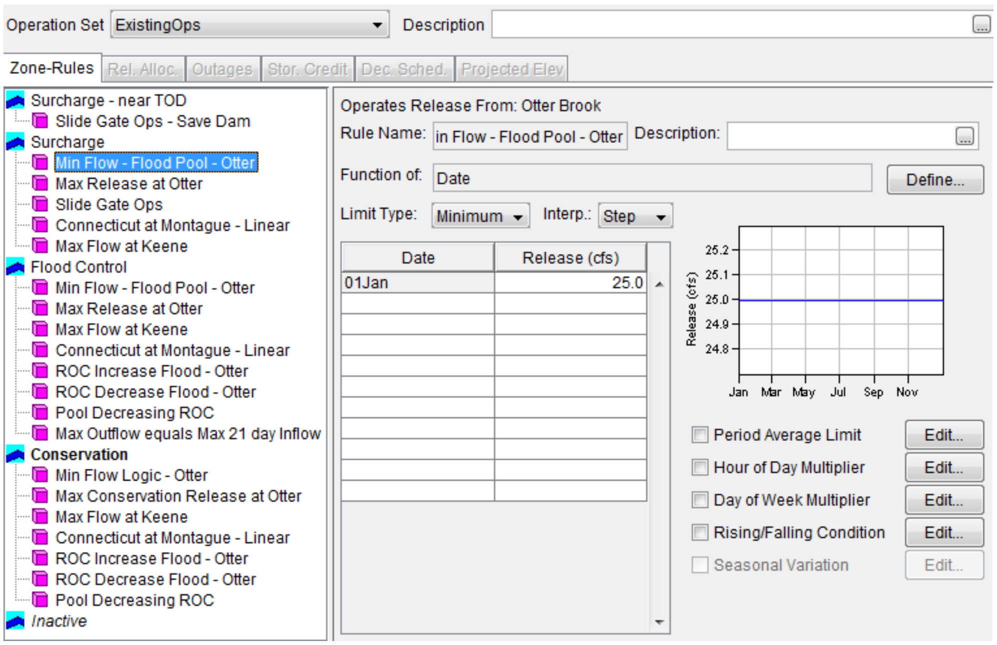


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow-Flood Pool-Otter

3. *Max Release at Otter*

Figure 9 shows the content of “Max Release at Otter” rule. This rule shows the maximum allowable release from dam.

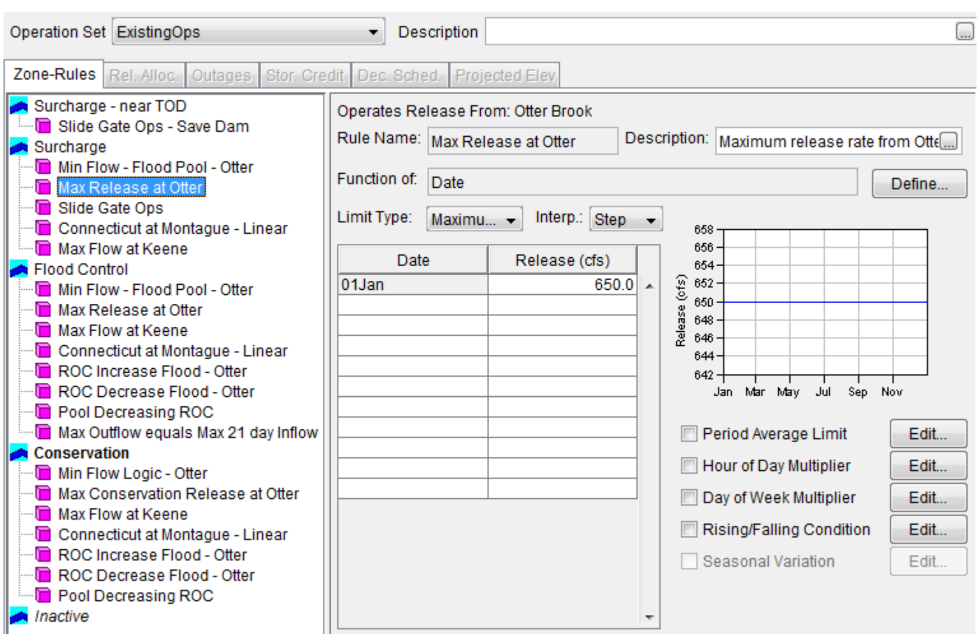


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Release at Otter

4. *Slide Gate Ops*

Figure 10 shows the content of "Slide Gate Ops" rule. This rule represents the maximum allowable release from Slide gates as a function of pool elevation when the pool is in Surcharge zone.

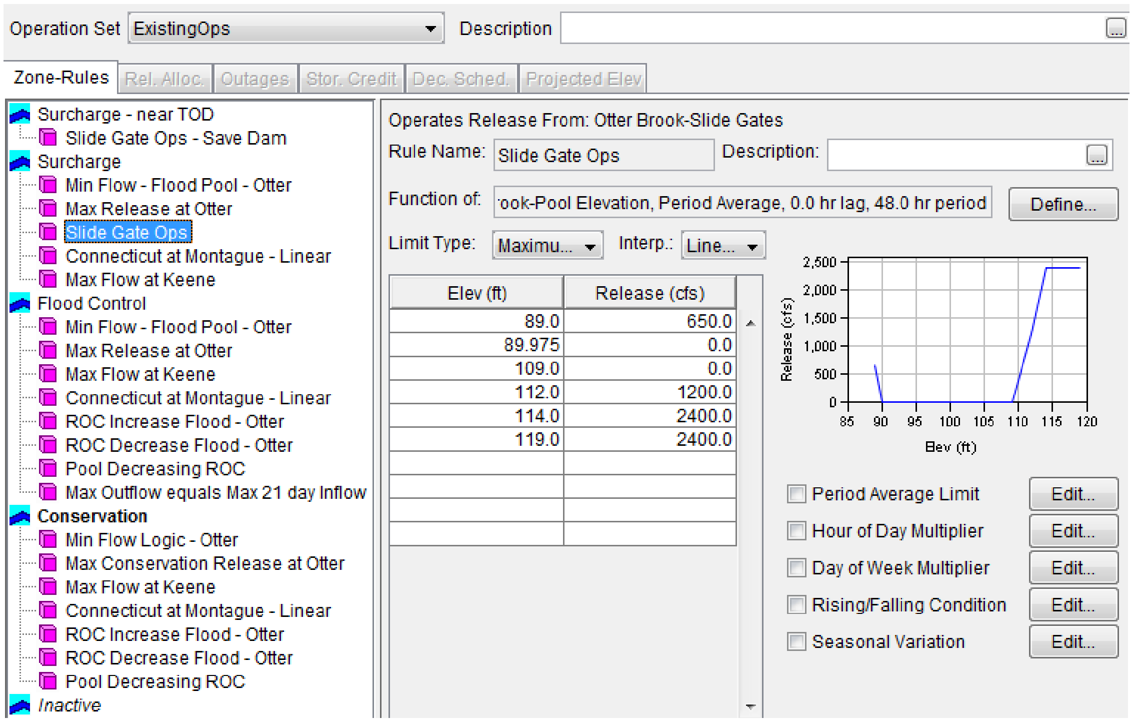


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Slide Gate Ops

5. Connecticut at Montague-Linear

Figure 11 shows the content of "Connecticut at Montague-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montague. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

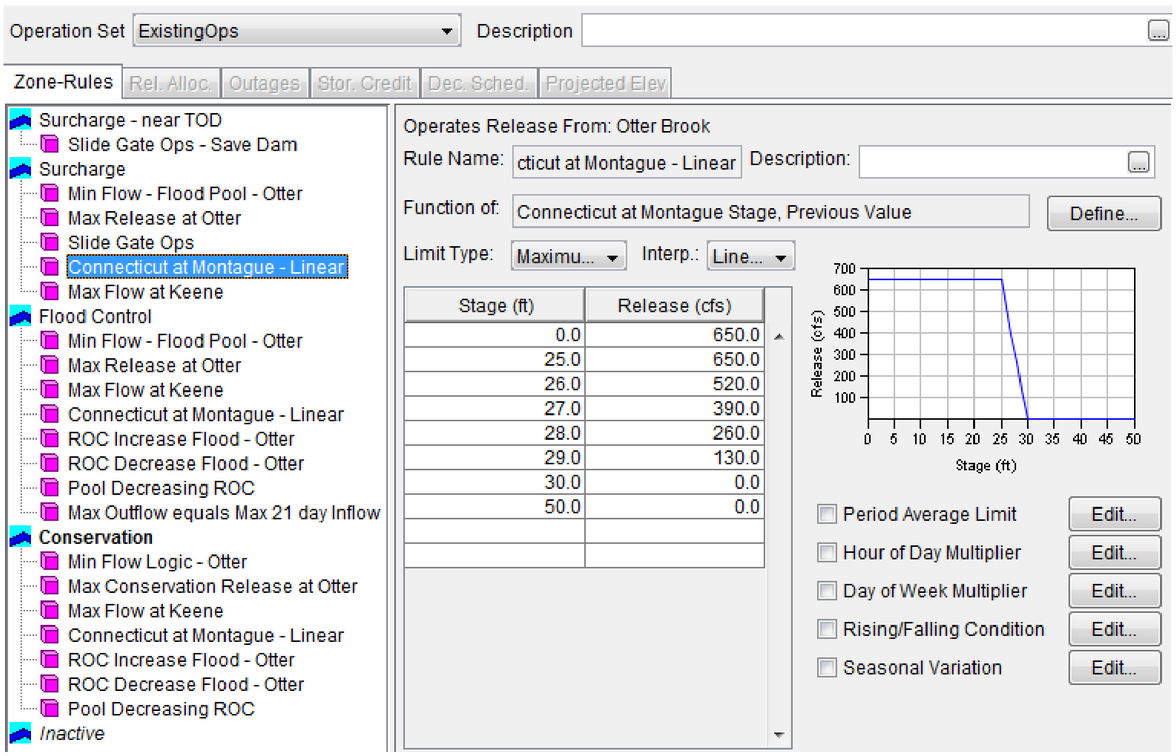


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague-Linear

6. *Max Flow at Keene*

Figure 12 shows the content of "Max Flow at Keene" rule. This rule represents the maximum allowable flow downstream at the point Ashuelot+Otter Brook.

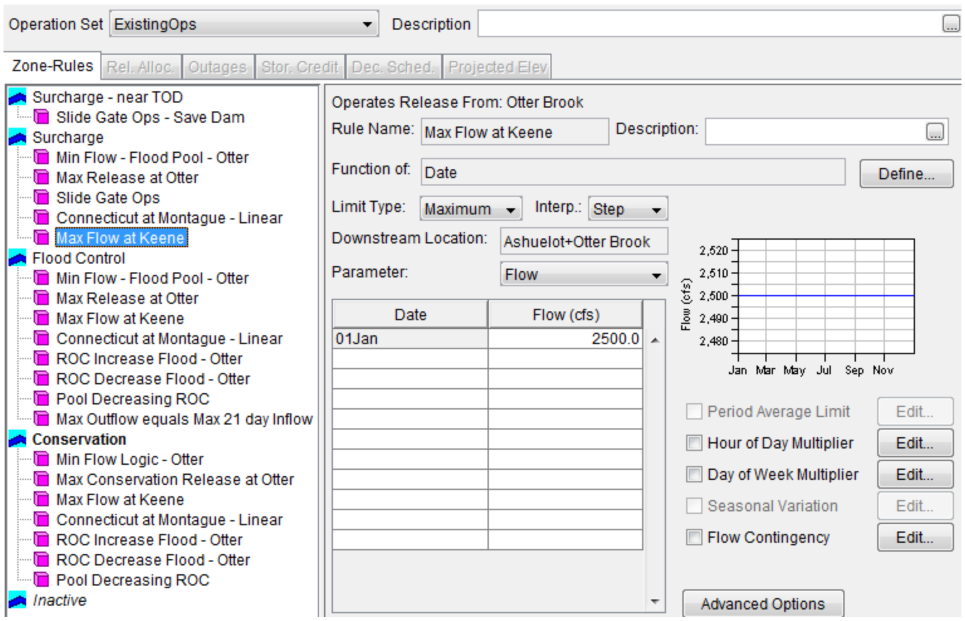


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max flow at Keene

7. *ROC Increase Flood-Otter*

Figure 13 shows the content of "ROC Increase Flood-Otter" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Otter Brook dam.

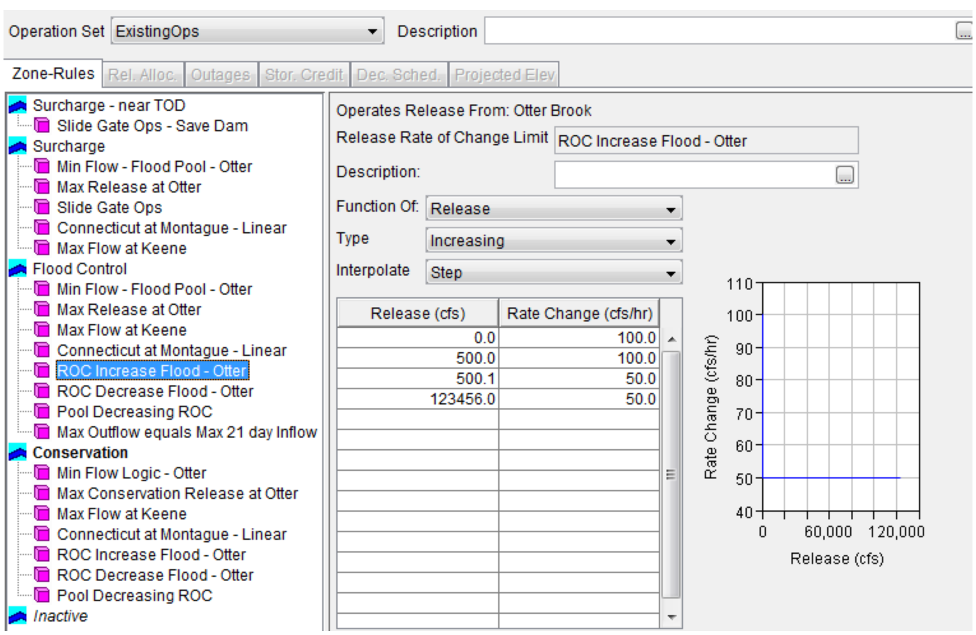


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – ROC Increase Flood-Otter

8. *ROC Decrease Flood-Otter*

Figure 14 shows the content of "ROC Decrease Flood-Otter" rule. This rule shows the maximum allowable decreasing release rate of change.

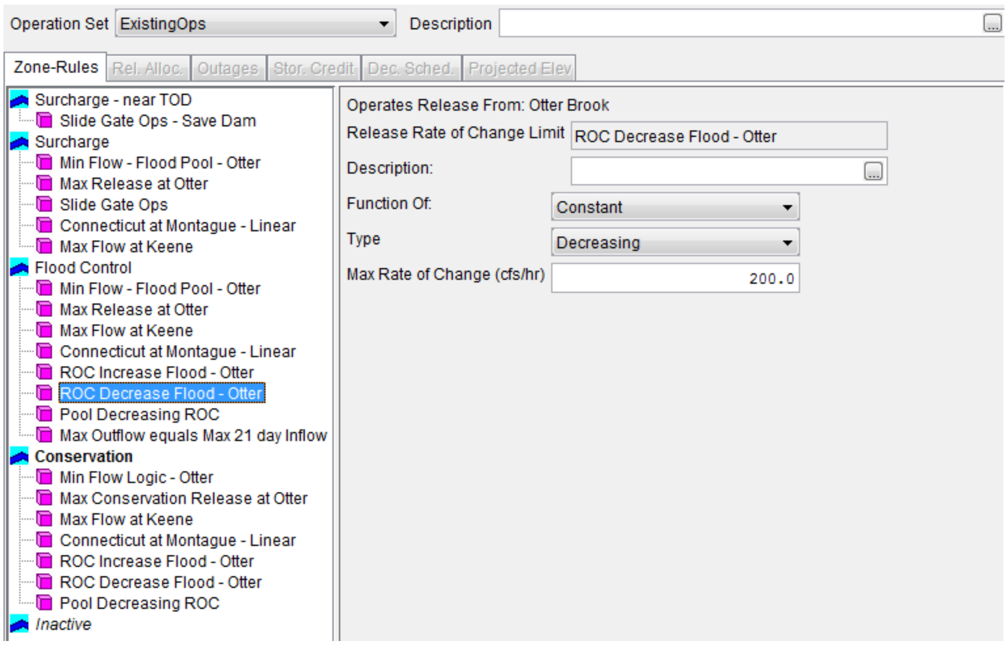


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet – ROC Decrease Flood-Otter

9. *Pool Decreasing ROC*

Figure 15 shows the content of "Pool Decreasing ROC" rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

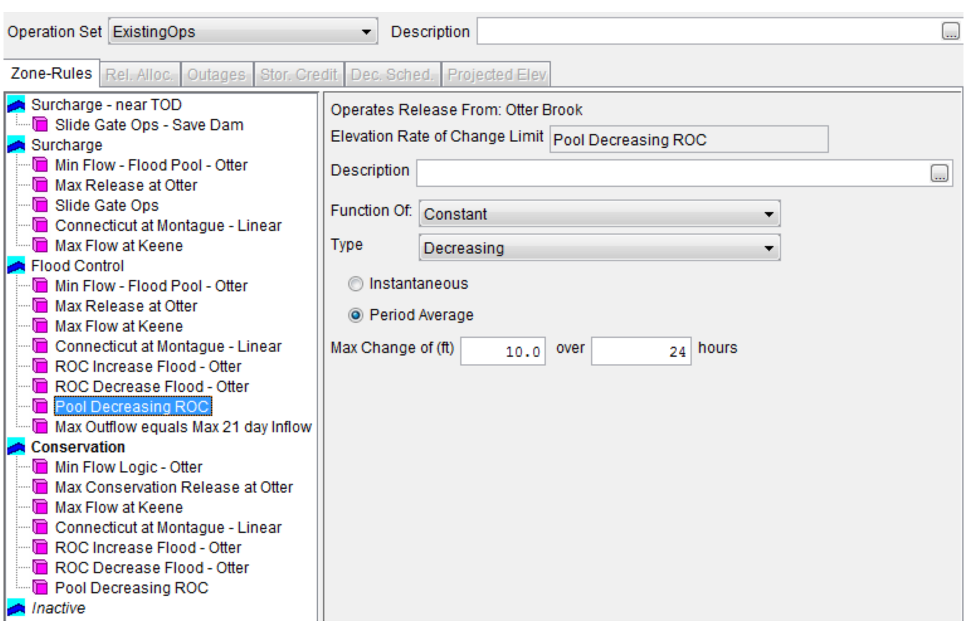


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet – Pool Decreasing ROC

10. Max Outflow equals Max 21 day Inflow

Figure 16 shows the content of "Max outflow equals Max 21 day Inflow" rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

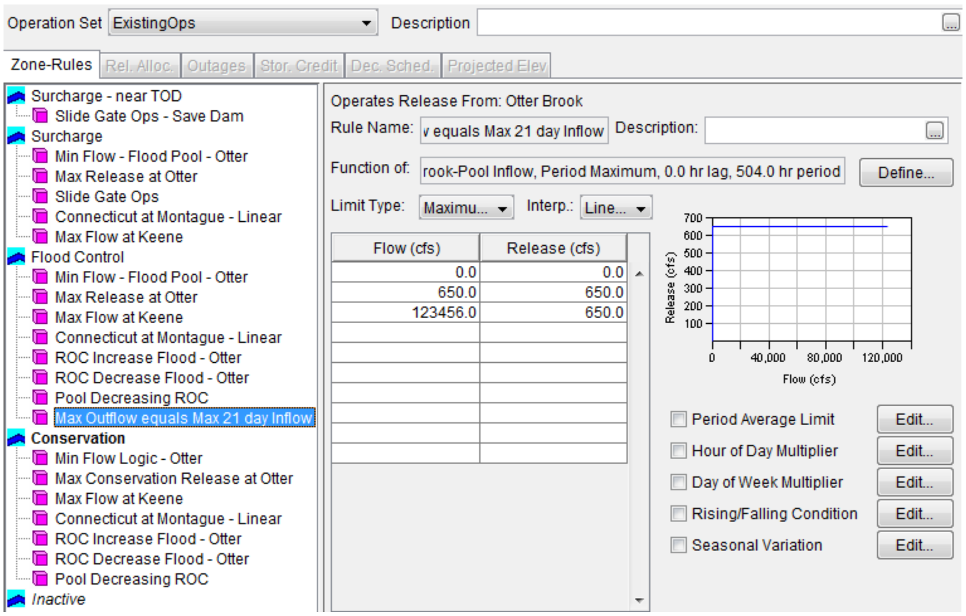


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals Max 21 day Inflow

11. Min Flow Logic-Otter

Figure 17 shows the content of "Min flow Logic-Otter" rule. This rule provides seasonal minimum releases from Otter Brook as a function of inflow.

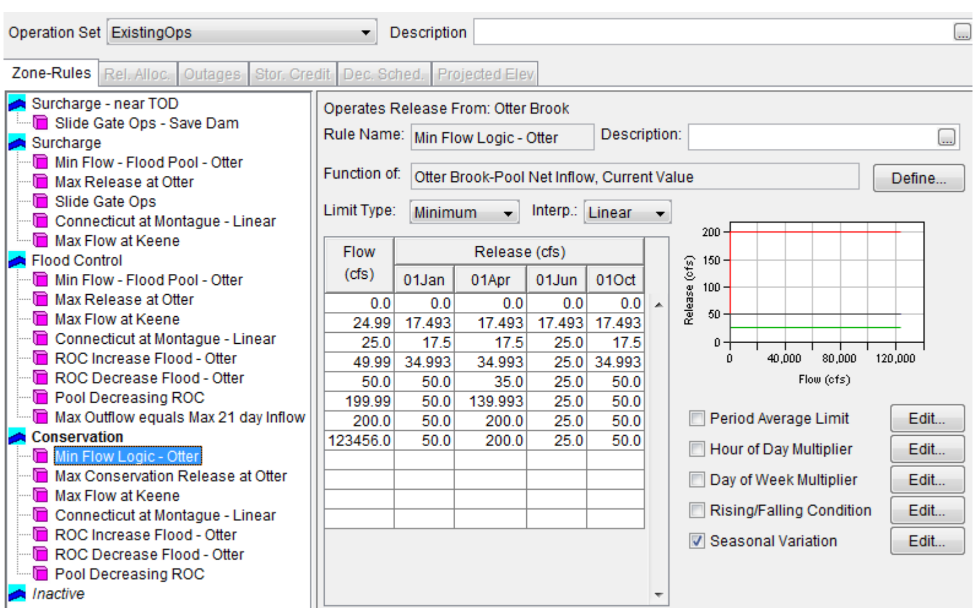


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic-Otter

Power Canal (Turners Falls)

I. Overview

Power Canal dam is one of the outlet canals from Turners Falls that is used for hydropower generation. It is part of the Turners Falls project but is modeled separately in the ResSim model because Gomez and Sullivan Engineers P.C., modeled it in this fashion.

Figure 1 shows the location of Power Canal Dam as it is represented in the HEC-ResSim model.

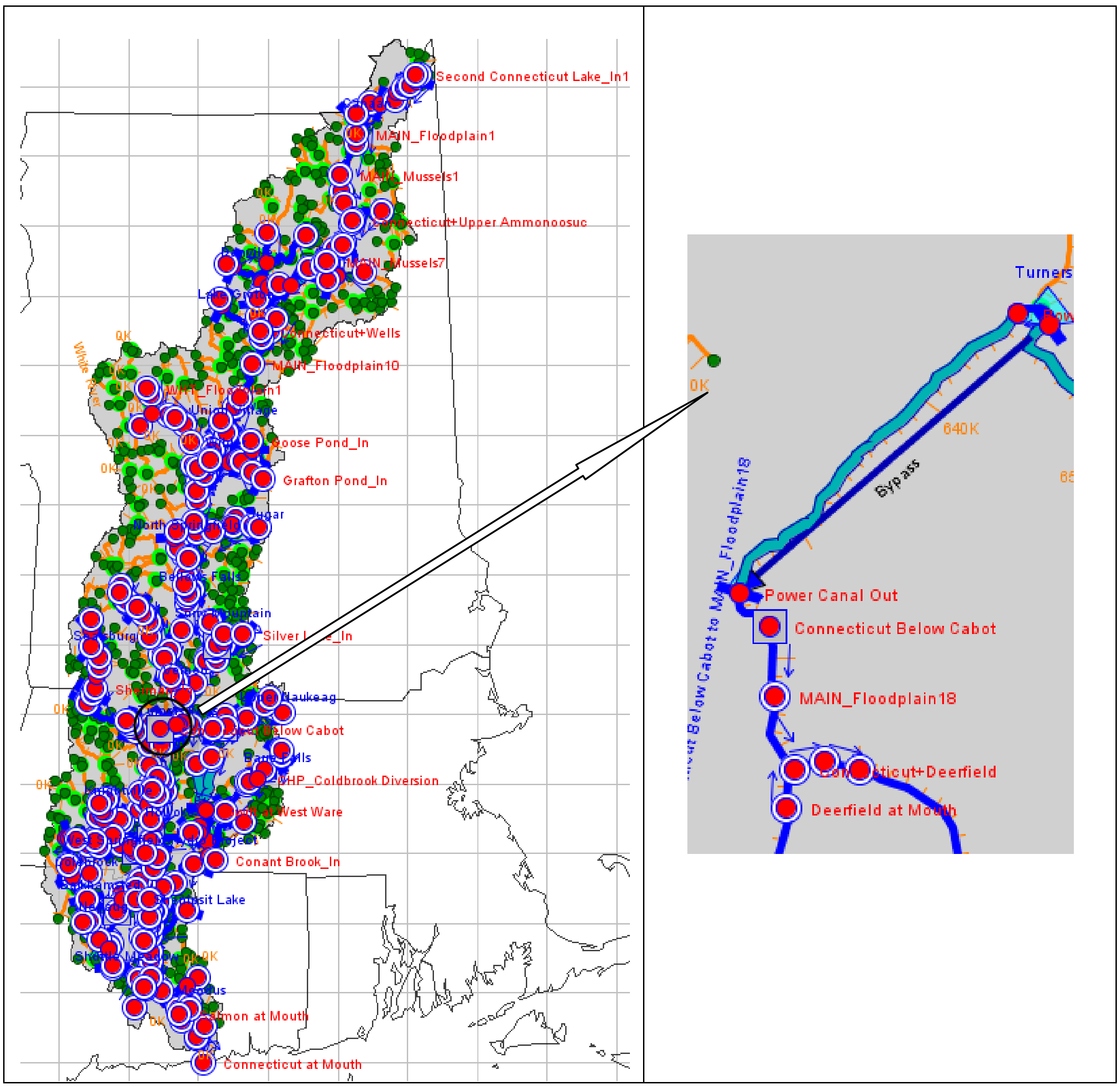


Figure 1: HEC-ResSim Map Display Showing Location of Power Canal dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 2. The dam consists of three types of outlets: (1) controlled Canal Fishways, and (2) Station No.1, and (3) Cabot Station as shown in Figure 3.

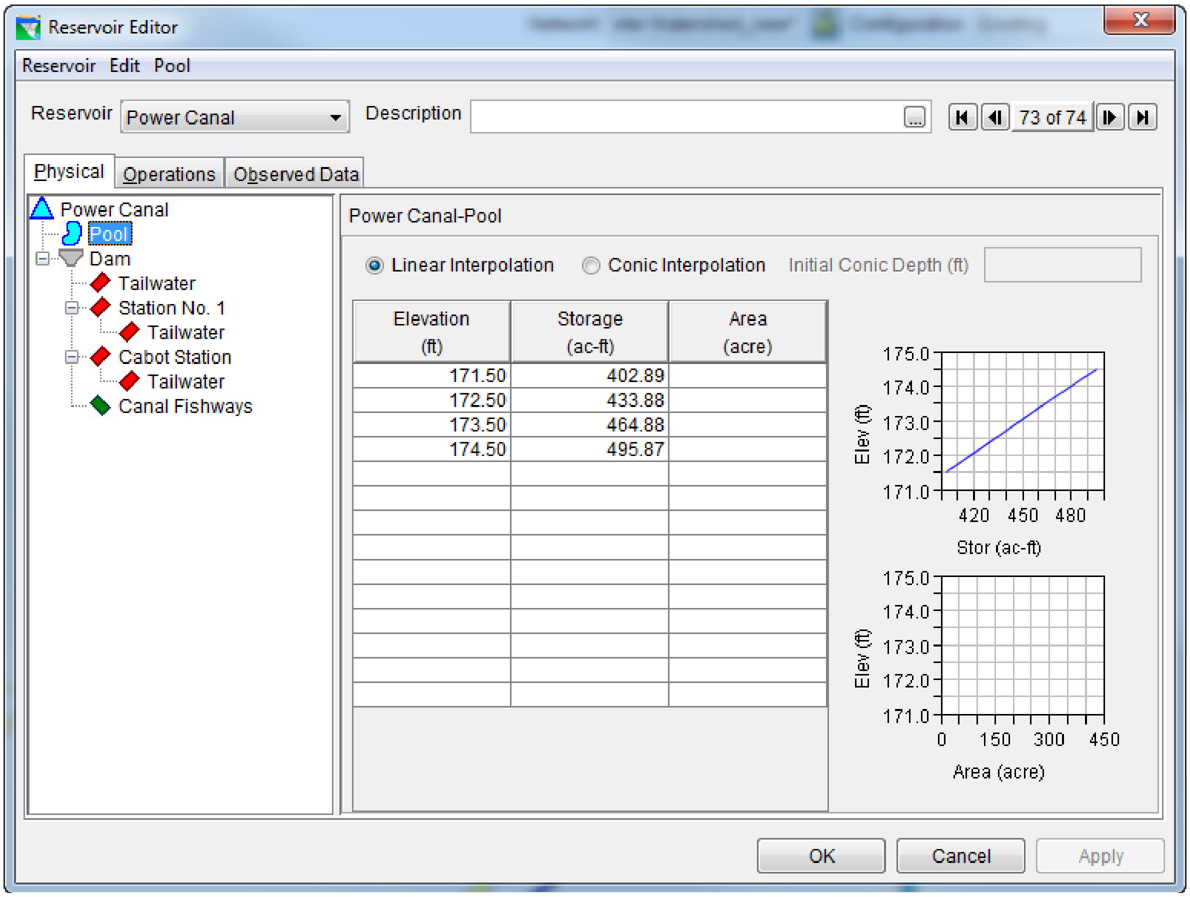


Figure 2: Reservoir Editor: Physical Tab -- Pool

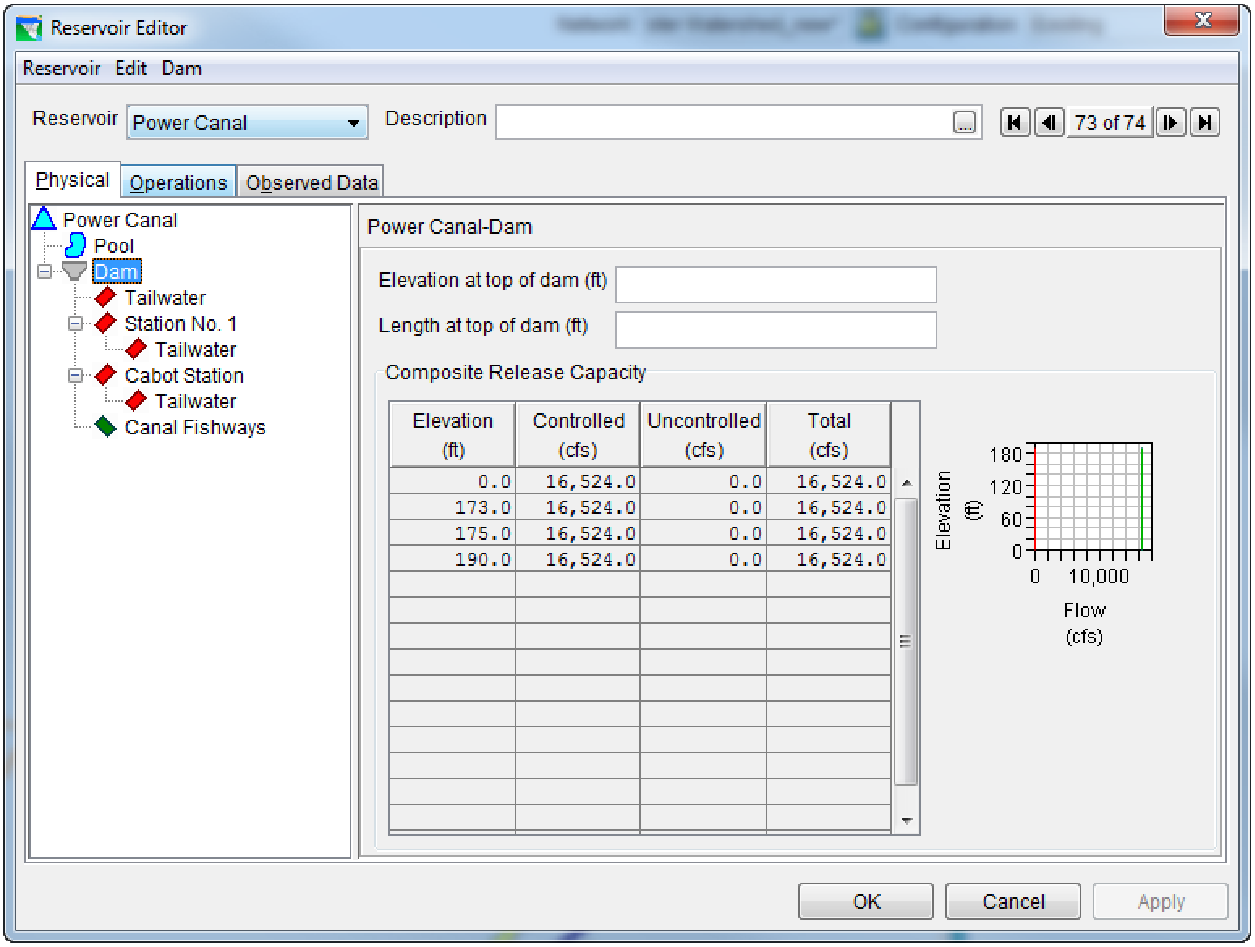


Figure 3: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 4 shows the definition of Power Canal's "ExistingOps" operational zones, which consist of zones of Flood Control (174 ft), Normal Pool (173.5 ft), and Inactive zone (173.5 ft).

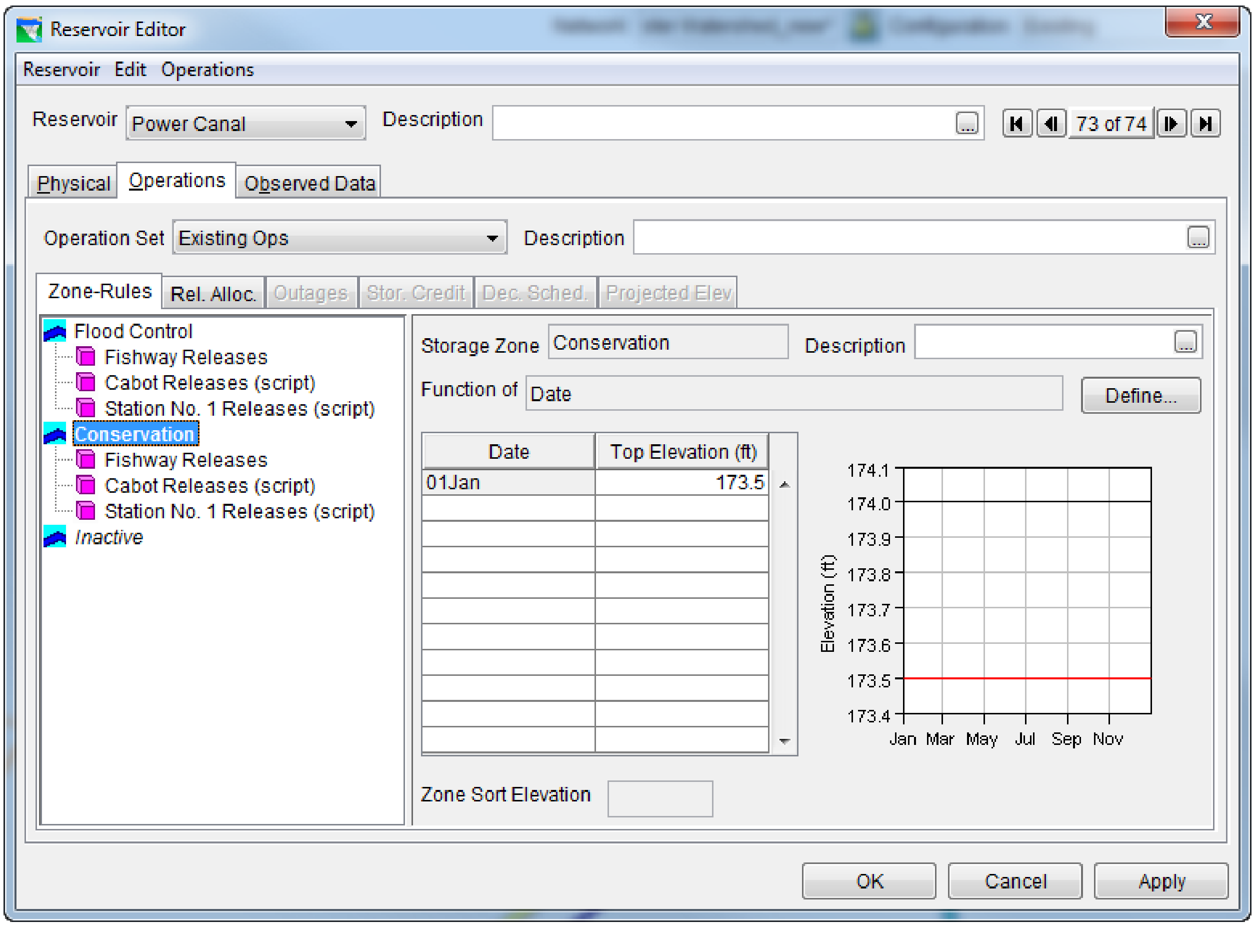


Figure 4: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 5 shows a sequential release allocation approach specified for available outlets along Power canal Dam. The available outlets are given an order of priority for release. The Cabot Station gets the release first until it reaches release capacity. The Station No.1 gets the remainder of the release until it reaches capacity. After the capacity through the Station No.1 is reached, the remainder of the release goes through the Canal Fishways.

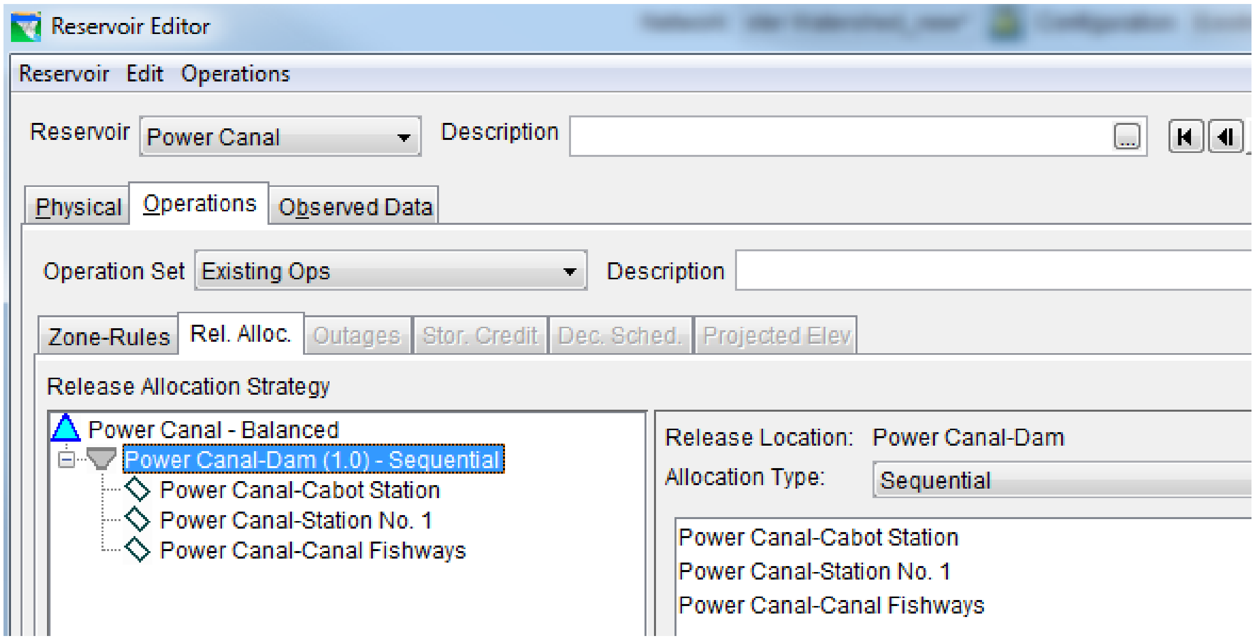


Figure 5: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

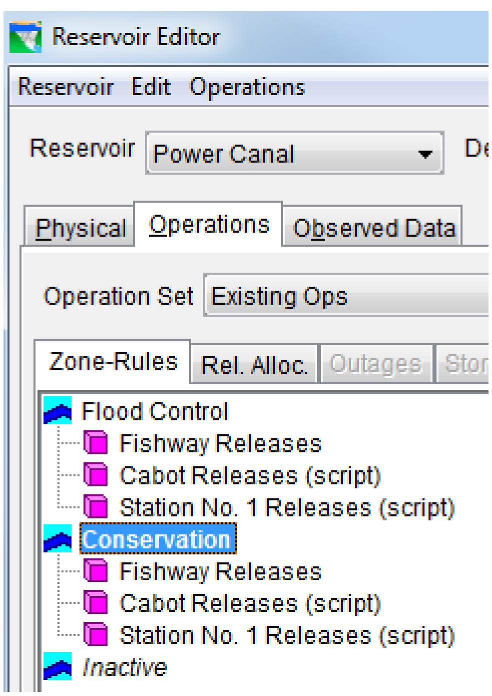


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Fishway Release

Figure 7 shows the content of "Fishway Release" rule. It shows the sum of Cabot ladder attraction flow and fishway flow, spillway ladder fishway flow (not attraction flow which releases from spillway gates), and Cabot log sluice for downstream fish passage. Gatehouse ladder attraction flow and fishway flow release to the canal and are available for generation so are not included here. Values of 386 cfs include the cabot and spillway ladders, values of 586 cfs include those two ladders plus the Cabot log sluice, and values of 200 cfs include the log sluice only.

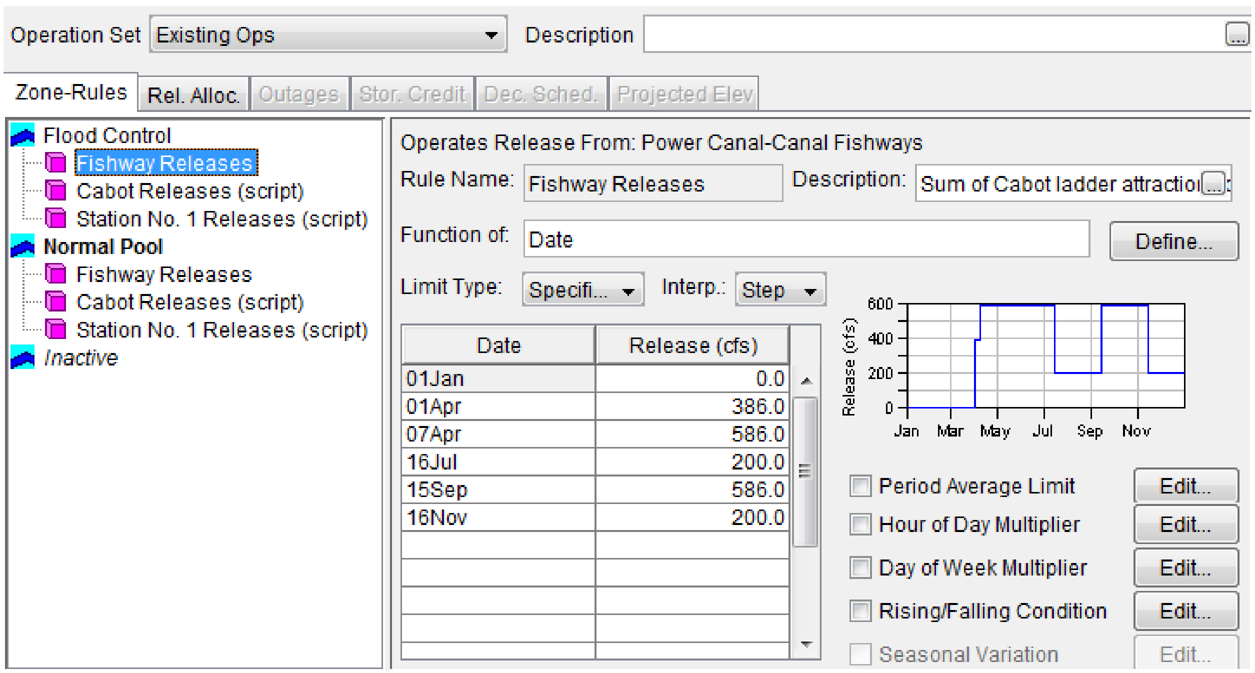


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Fishway Release

2. Cabot Release(script)

Figure 8 shows the content of “Cabot Relesea” rule. This script calculates the Power Canal's inflow and subtracts the seasonal fishways flow to determine how much flow should be released through Cabot Station. 1400 cfs corresponds to the minimum flow to run one unit at Cabot; 13,728 cfs is Cabot's capacity.

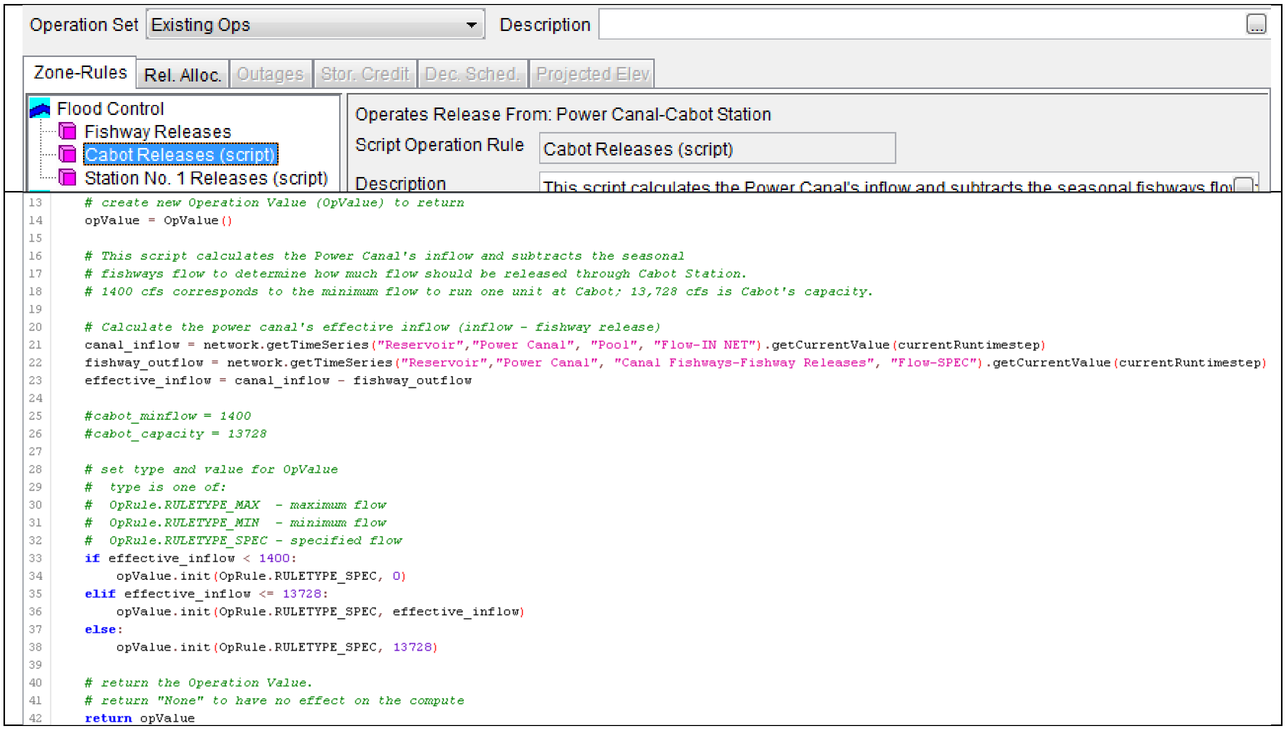


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Cabot Relesae

3. Station No.1 Releases(script)

Figure 9 shows the content of “Station No.1 Releases” rule. This script calculates the Power Canal's inflow and subtracts the seasonal fishways flow to determine how much flow should be released through Station No. 1. 1400 cfs corresponds to the minimum flow to run one unit at Cabot; 13,728 cfs is Cabot's capacity.

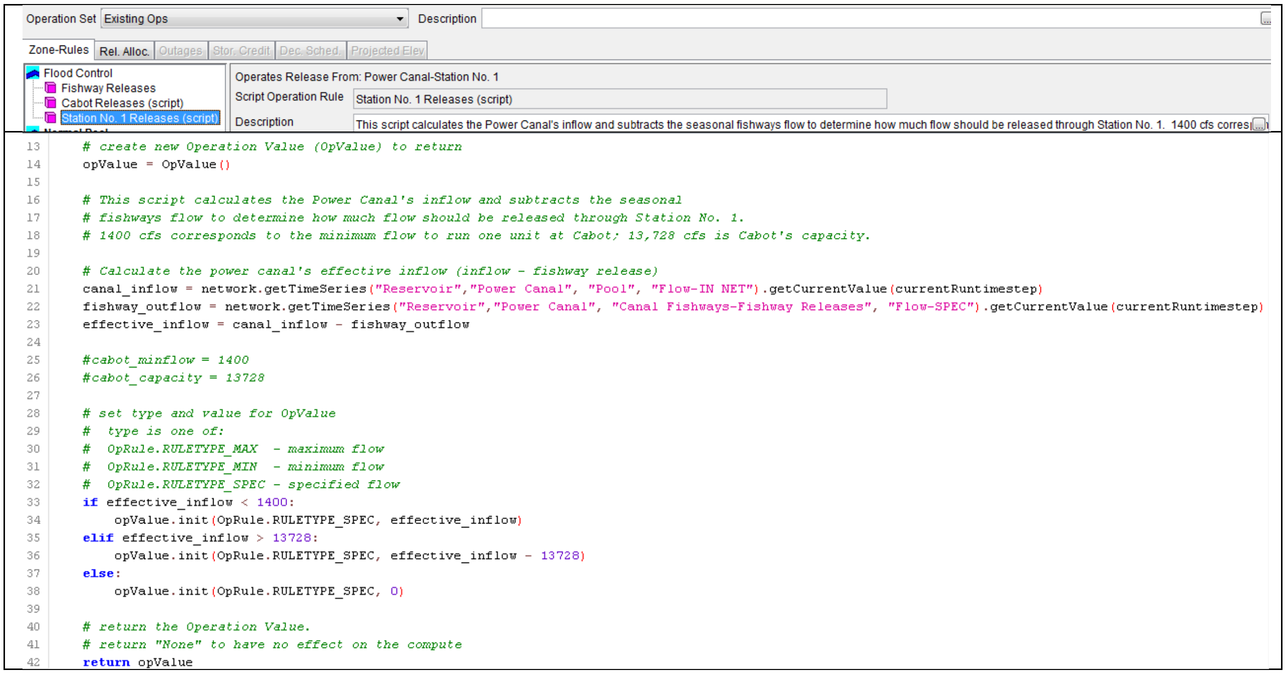


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Station No.1 Releases(script)

Quabbin Windsor

I. Overview

The Quabbin Windsor dam is a very large project located on the Swift River that feeds into the Chicopee River. It is owned and operated by the Massachusetts Water Resources Authority (MWRA) and is used for water supply for the City of Boston.

Figure 1 shows the location of Quabbin Windsor dam as it is represented in the HEC-ResSim model. Figure 2 show a photo of Quabbin Windsor dam.

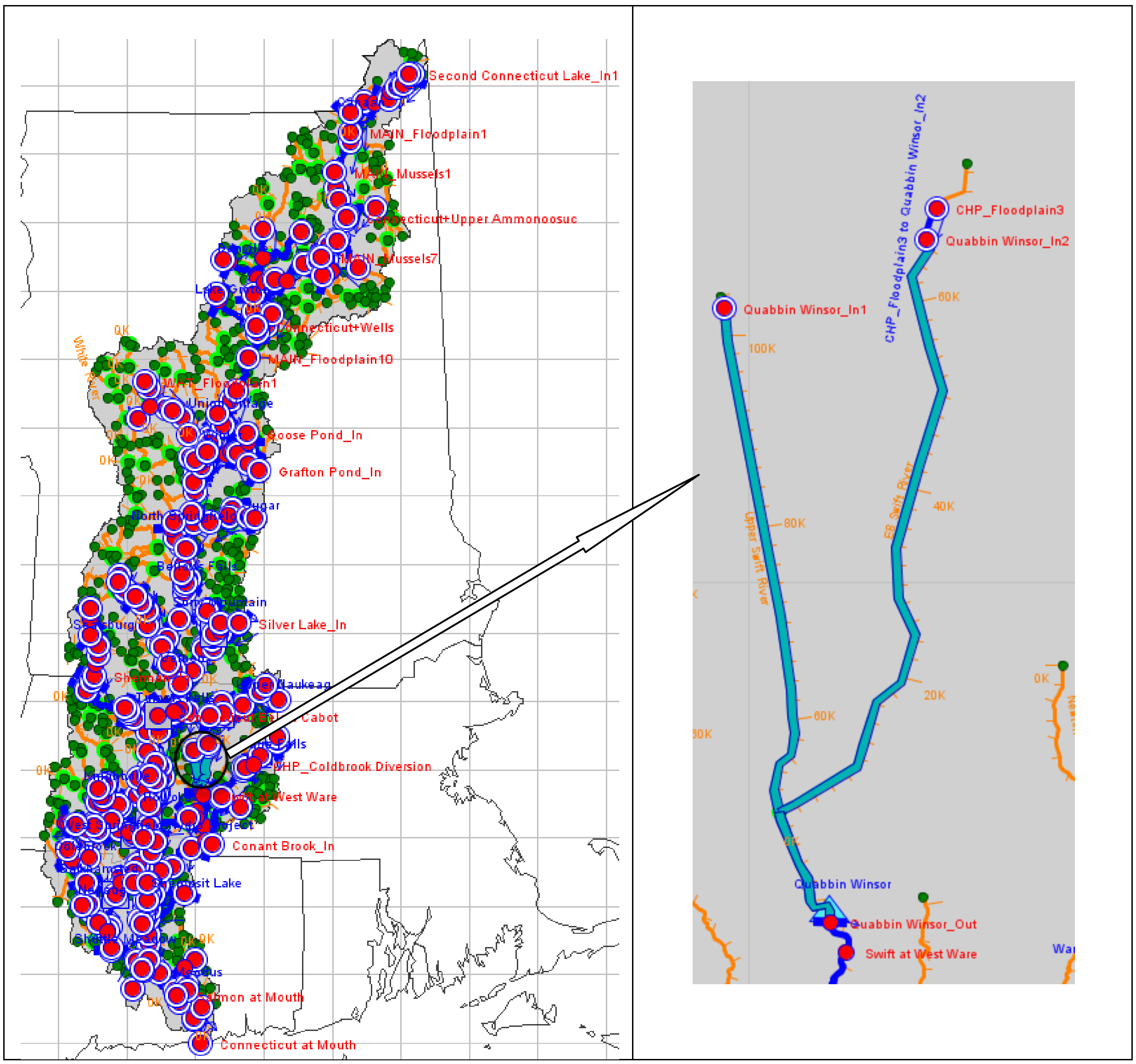


Figure 1: HEC-ResSim Map Display Showing Location of Quabbin dam

Figure 2: Photo of Quabbin Windsor dam.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[79]. The dam consists of three types of outlets: (1) controlled Bypass to Swift River, (2) uncontrolled spillway, (3) uncontrolled Auxillary Spillway as shown in Figure 4.

[79] Phase I Report. 1978.

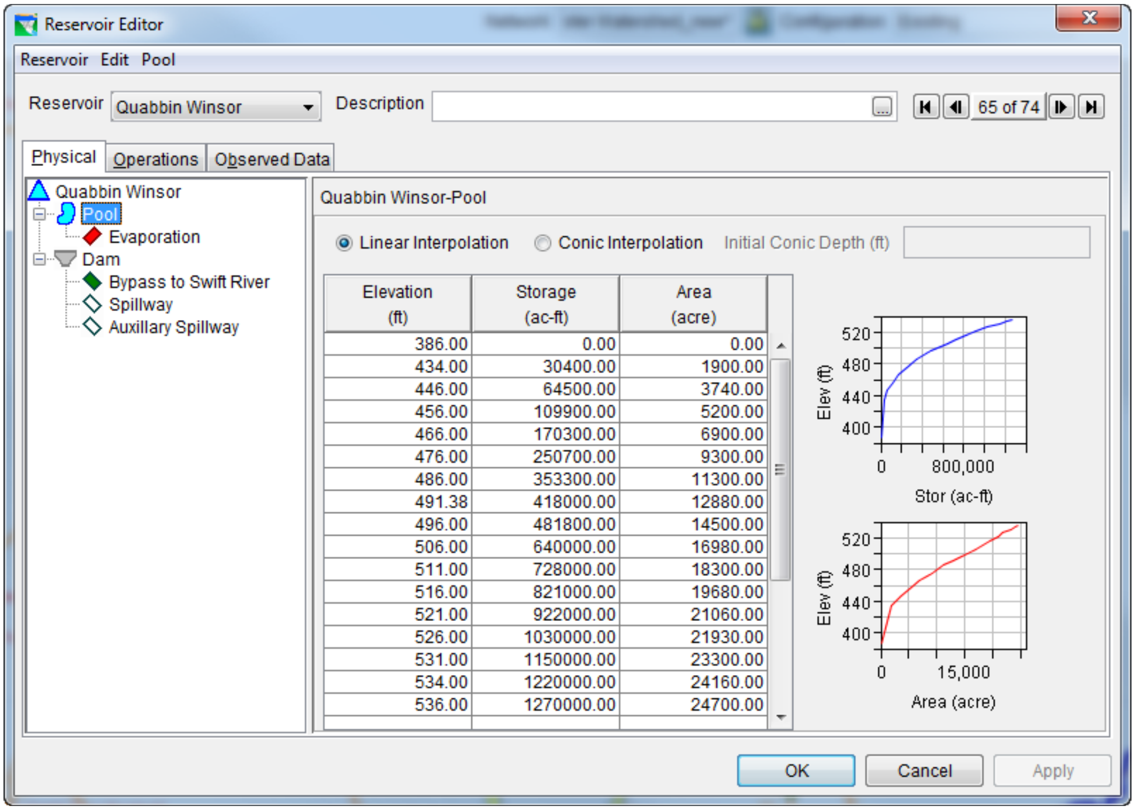


Figure 3: Reservoir Editor: Physical Tab -- Pool

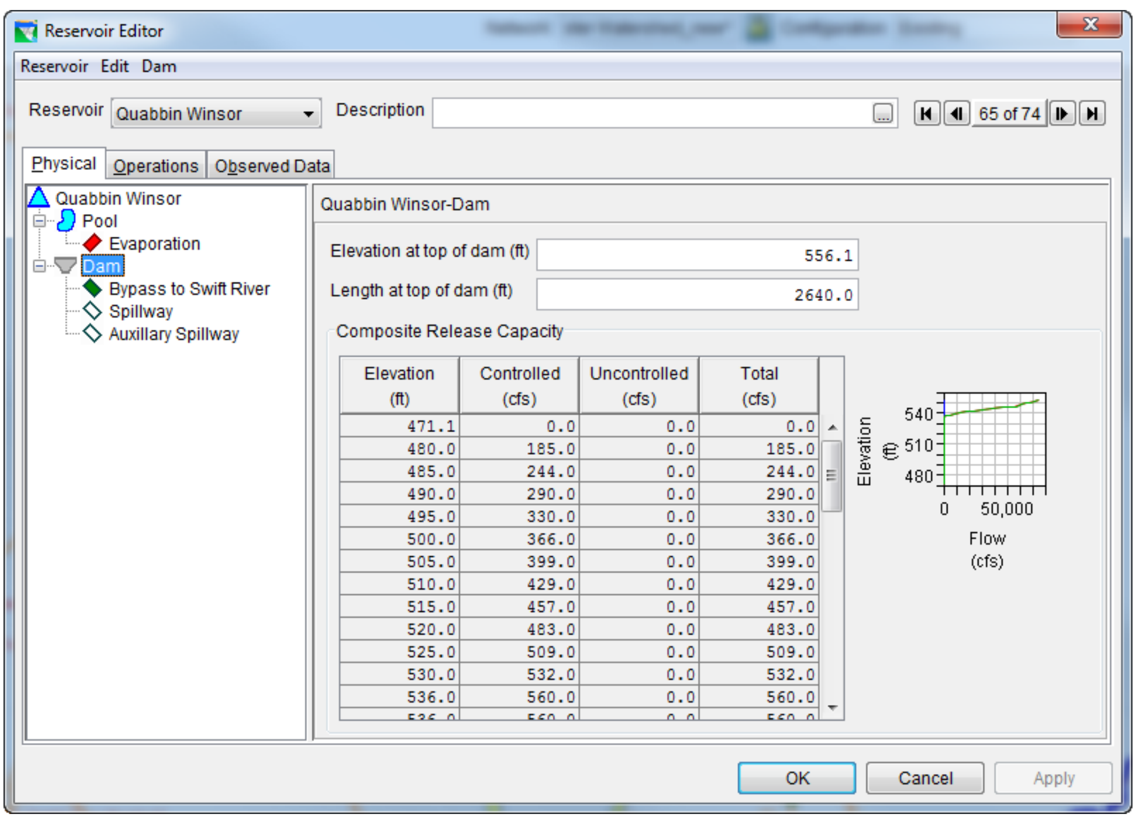
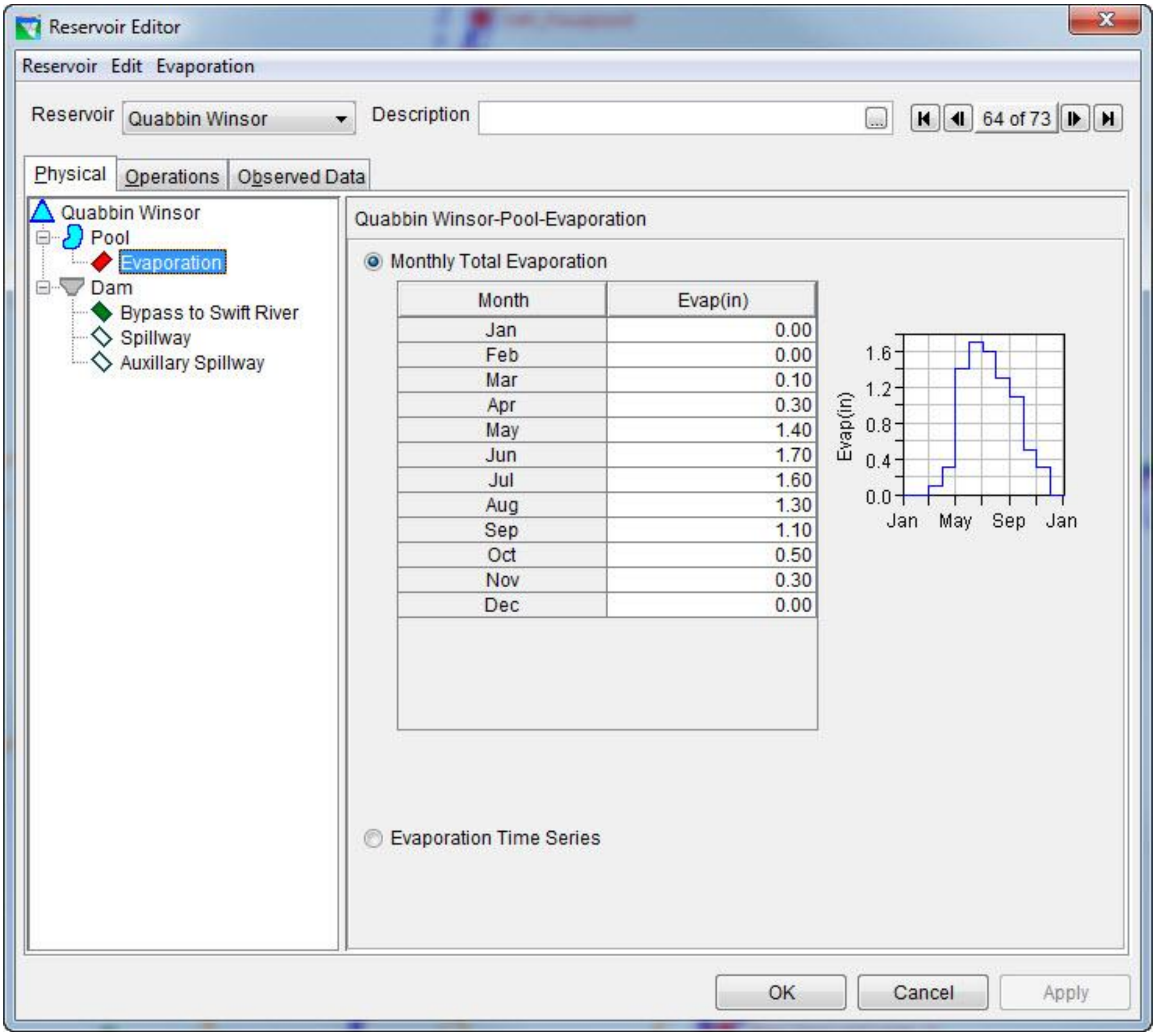


Figure 4: Reservoir Editor: Physical Tab -- Dam

Figure 5 shows the monthly evaporation factors that were accounted for Quabbin Windsor, due to the large size of the reservoir.



III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Quabbin's "ExistingOps" operational zones, which consist of zones of, Flood Control (556 ft), Conservation (536.05 ft), Min Water Supply Intake (434 ft), and Inactive zone (380 ft)[1].

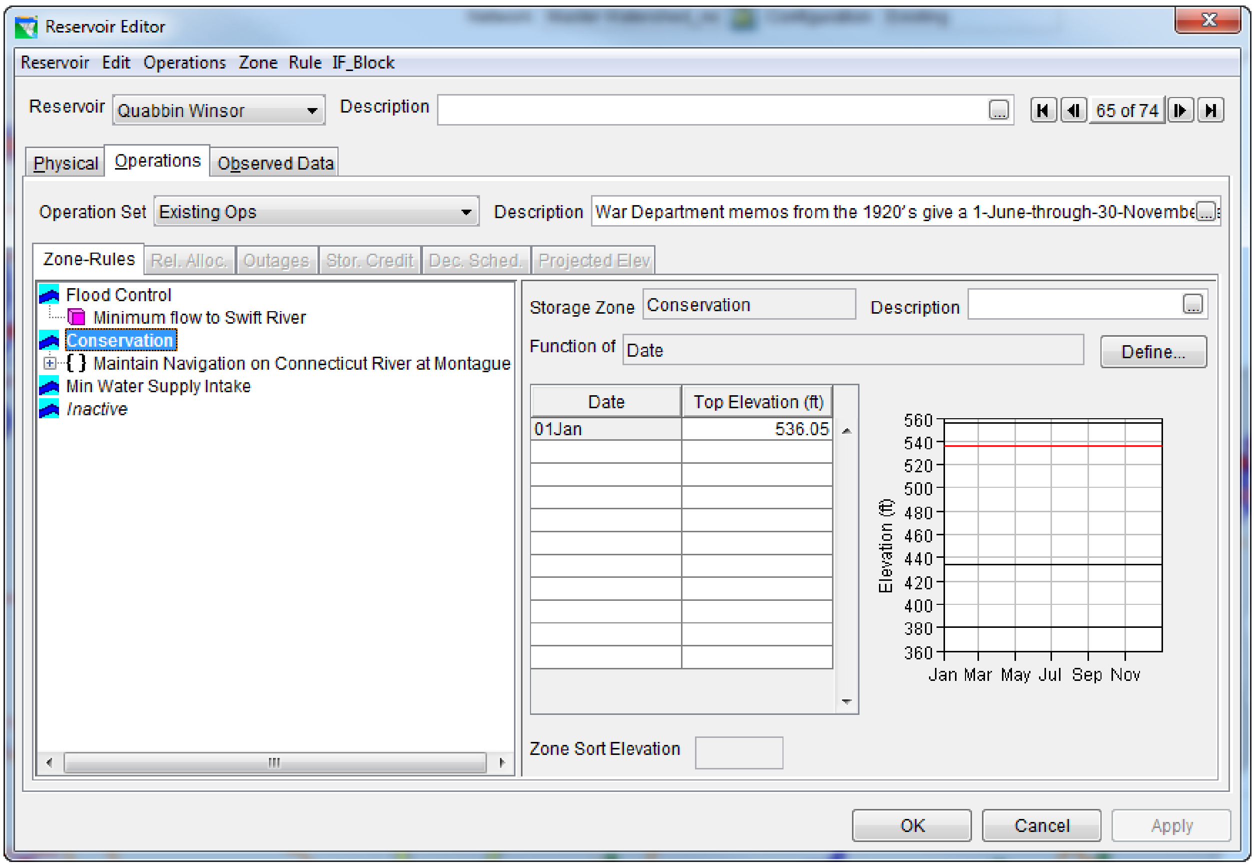


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[1]. Quabbin, the largest reservoir in the basin and one of the major water supply sources for the City of Boston, had its water withdrawals estimated from a combination of monthly pool levels and annual water supply volumes from 2006 to 2009, provided by the Massachusetts Water Resources Authority's (MWRA) website and the Massachusetts Department of Environmental Protection (MADEP), which showed the pool is allowed to fluctuate seasonally. Gauged records of discharges from Quabbin and SYE flows gave some indication of the total volume that was diverted from the reservoir for water supply. These different facets were used to crudely estimate a withdrawal time series for the model period of record. The main goal was to remove a significant percentage of the total volume released from Quabbin into the Swift River. It is worth noting that in the mid 1980s, significant reductions in water supply demand as well as fixes to the system such as repairing leaking pipes began to be implemented that reduced the withdrawals from Quabbin. This is reflected in the water supply time series for Quabbin.

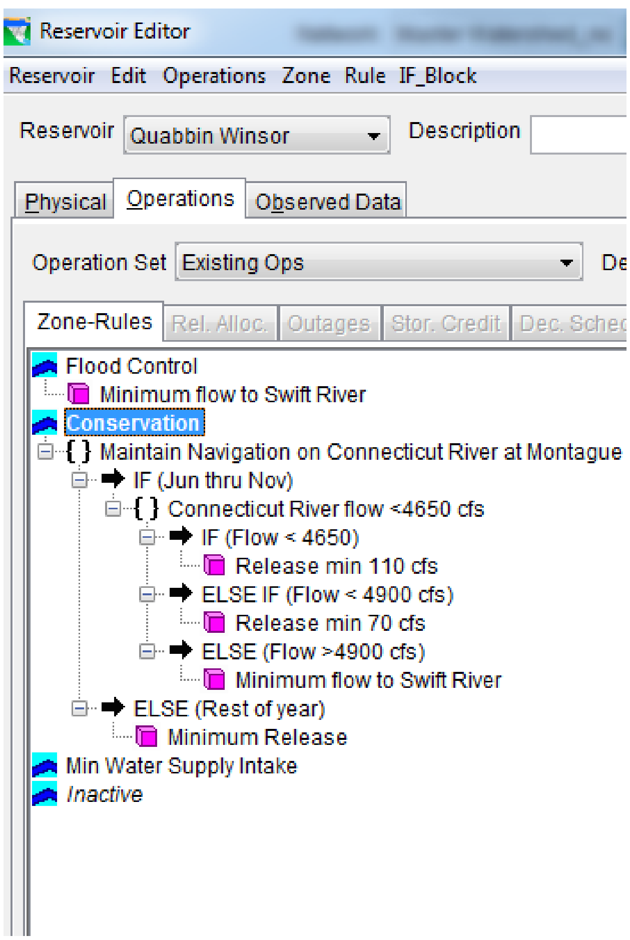


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Minimum flow to Swift River

Figure 7 shows the content of "Minimum flow to Swift River" rule. This rule shows a minimum flow from dam to swift river.

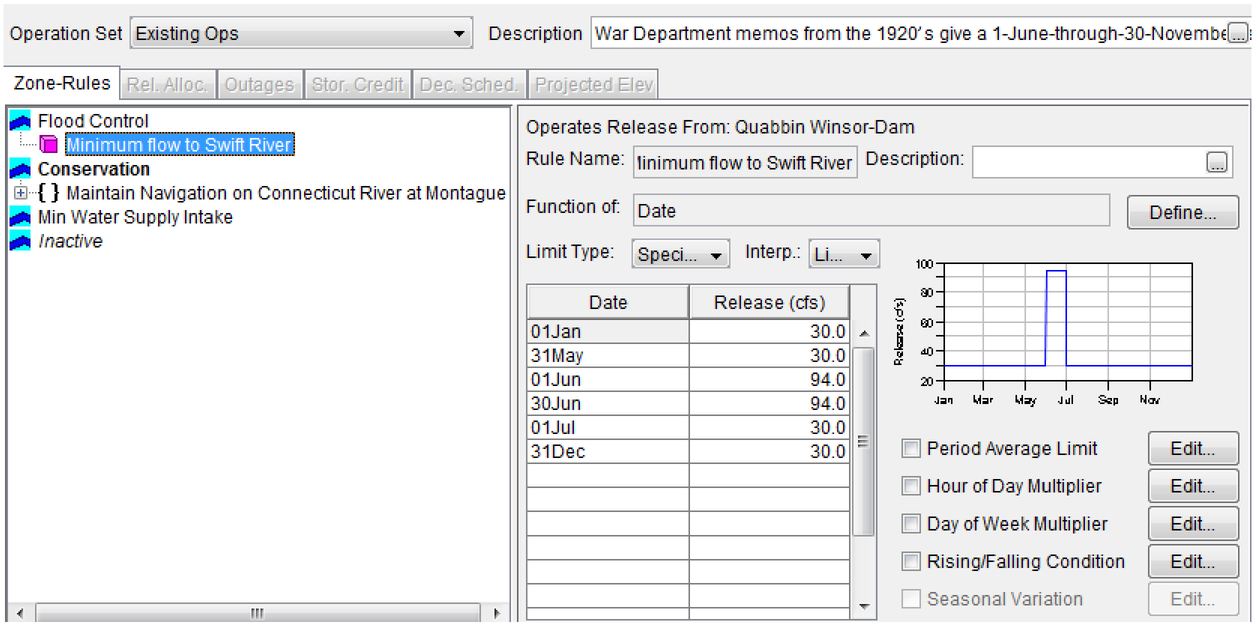
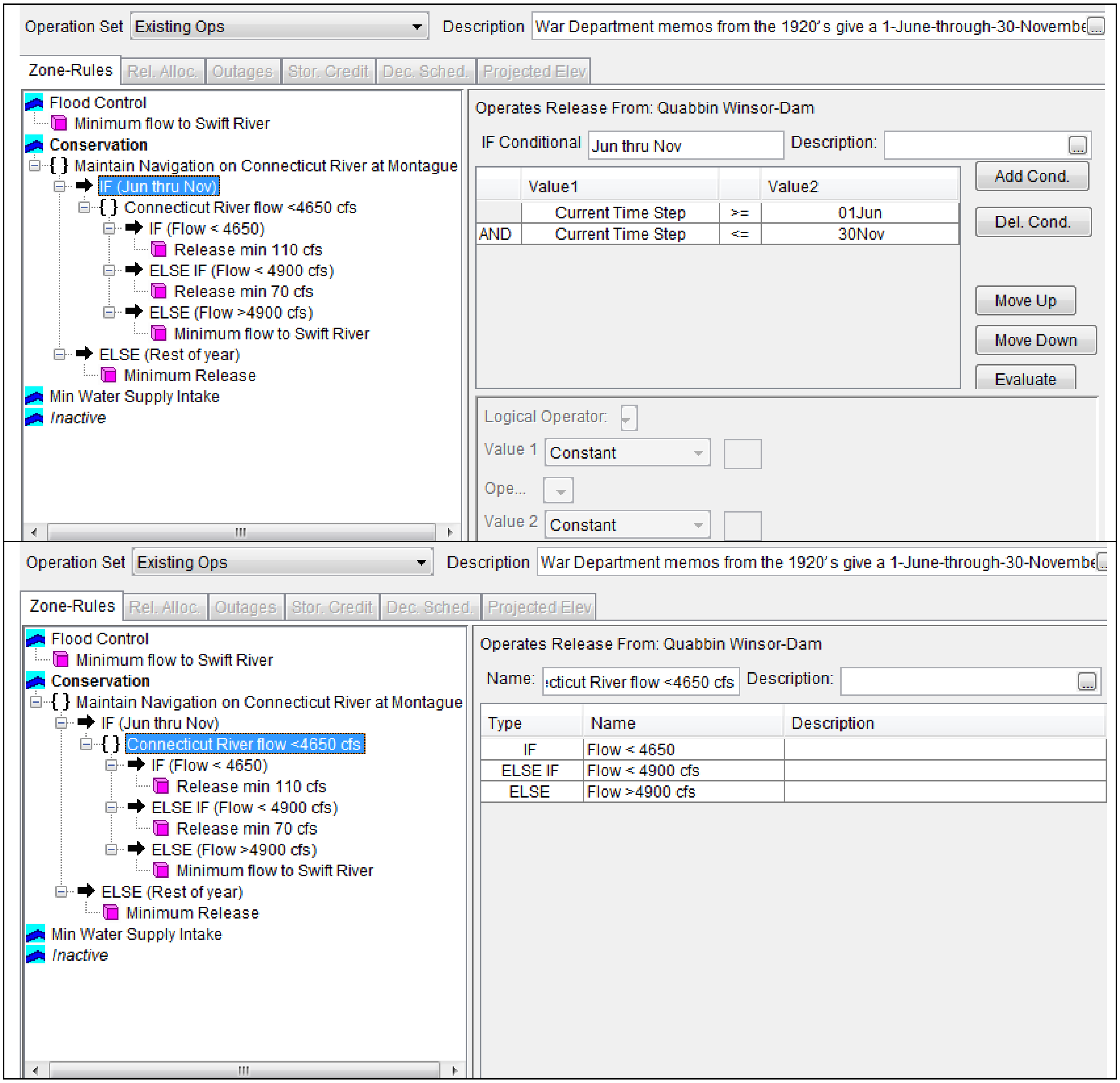
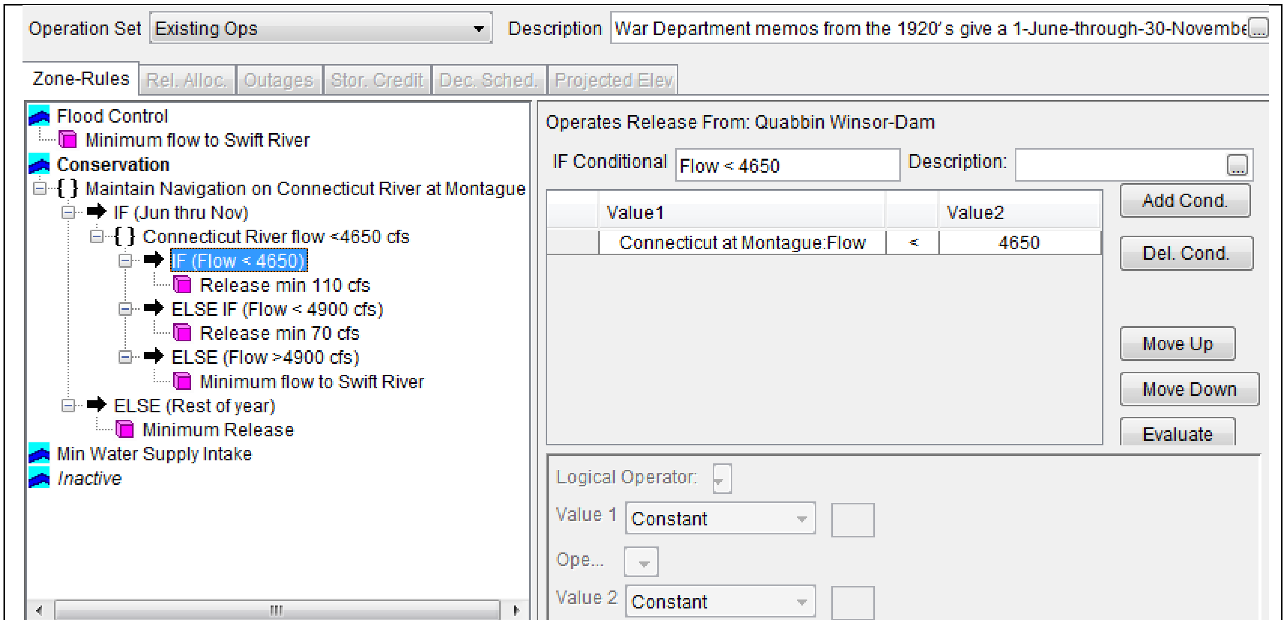


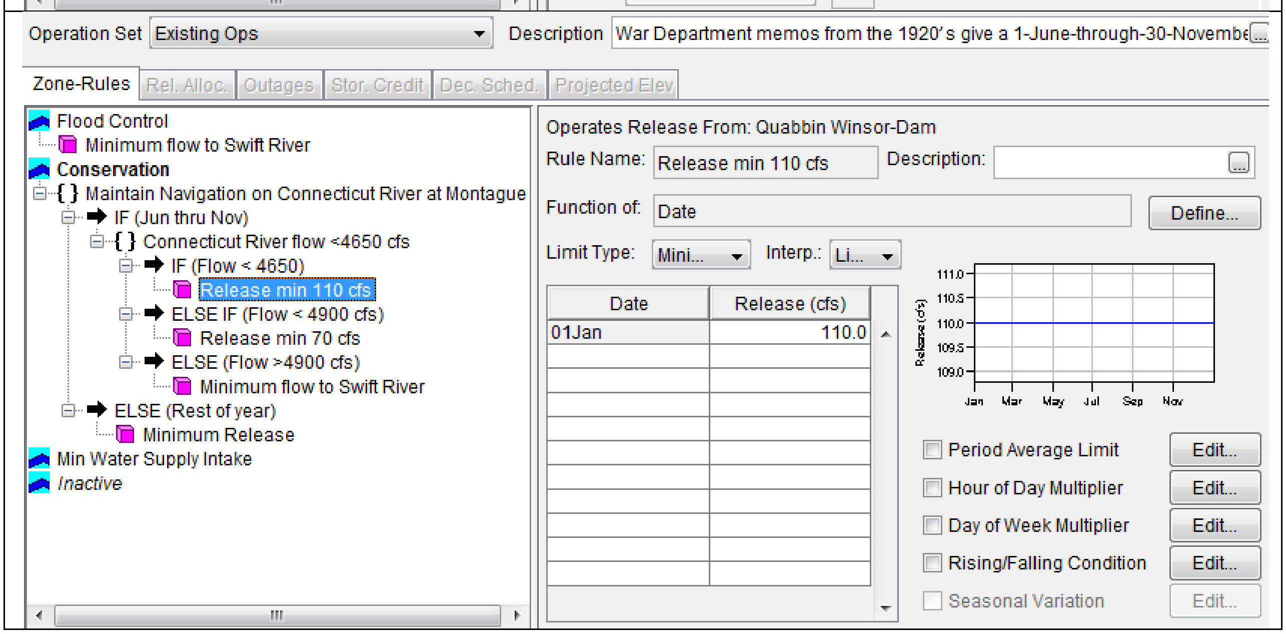
Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Minimum flow to Swift River

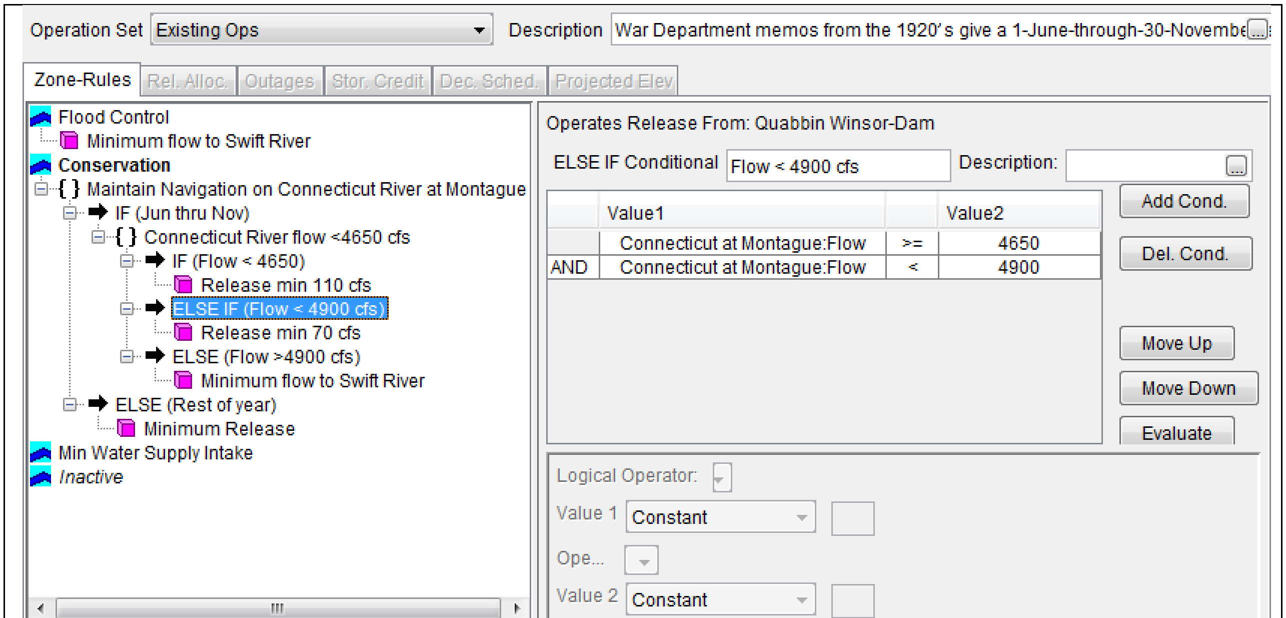
2. *Maintain Navigation on Connecticut River at Montague*

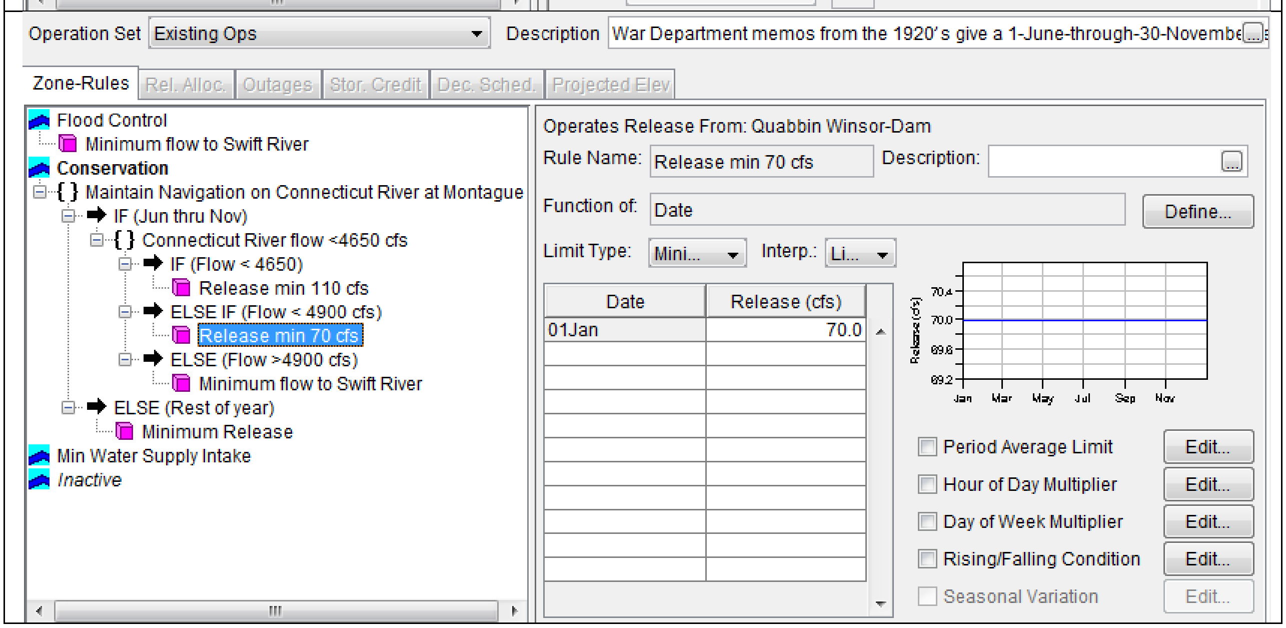
Figure 8 shows the content of “Maintain Navigation on Connecticut River at Montague” rule. This rule shows a minimum release from dam as a function of Inflow during Jun-Nov.

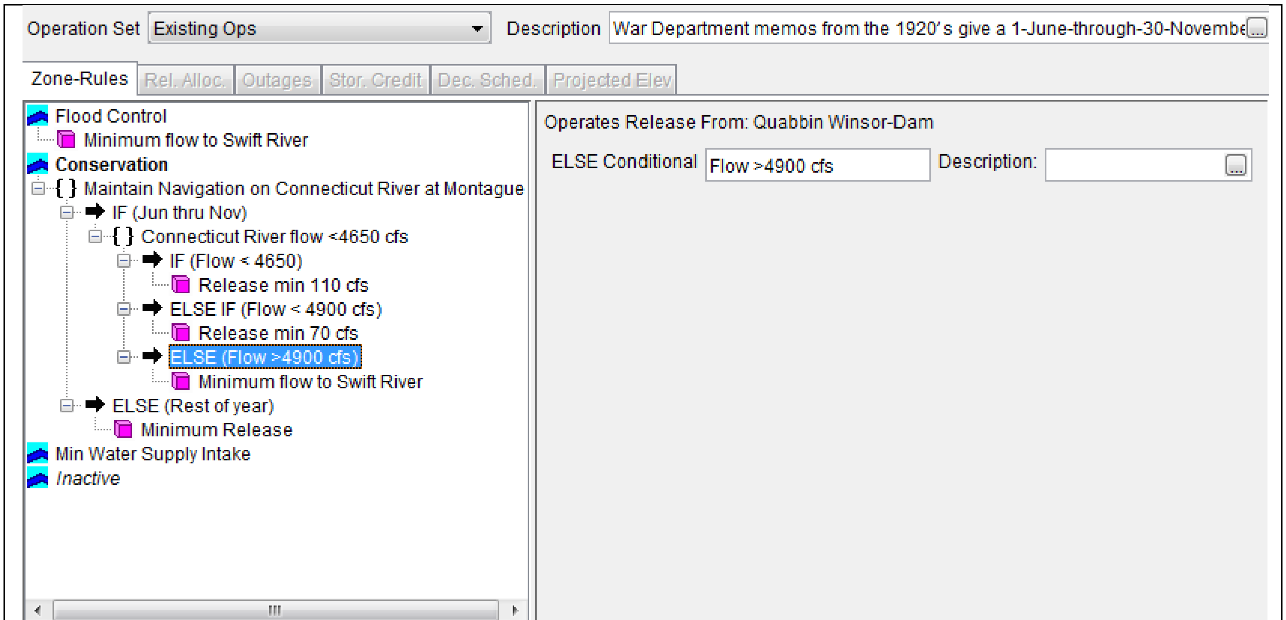


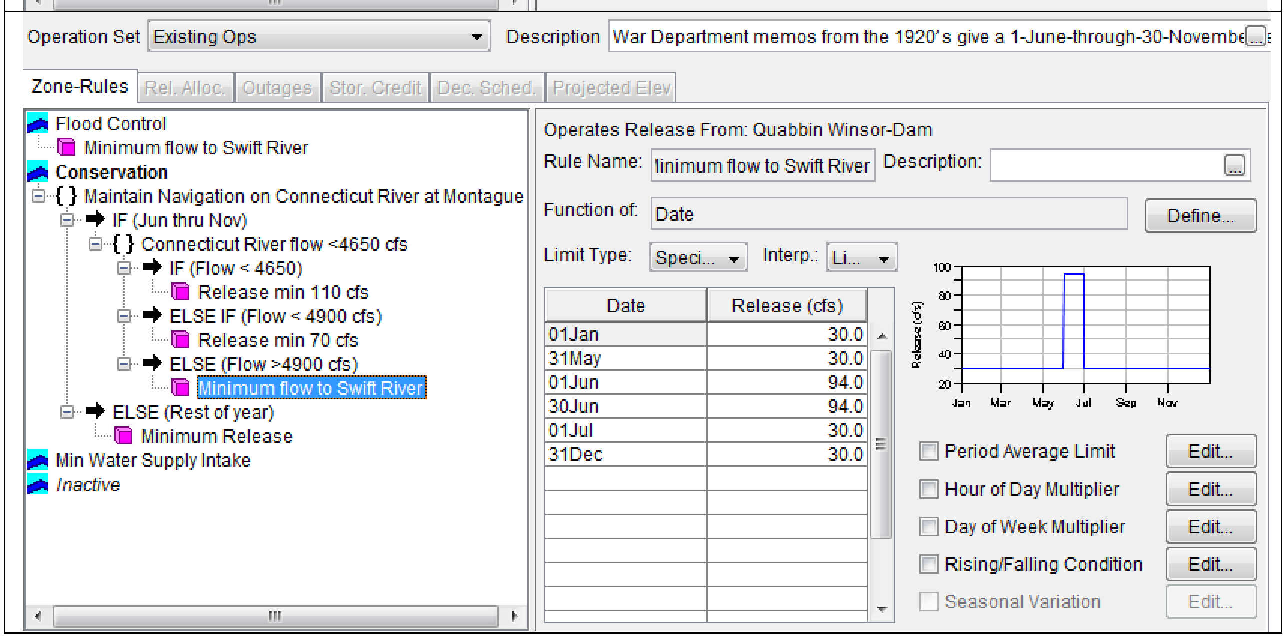

Operation Set
Existing Ops
Description
War Department memos from the 1920's give a 1-June-through-30-Novembe
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Flood Control
Minimum flow to Swift River
Conservation
Maintain Navigation on Connecticut River at Montague
IF (Jun thru Nov)
Connecticut River flow <4650 cfs
IF (Flow < 4650)
Release min 110 cfs
ELSE IF (Flow < 4900 cfs)
Release min 70 cfs
ELSE (Flow >4900 cfs)
Minimum flow to Swift River
ELSE (Rest of year)
Minimum Release
Min Water Supply Intake
Inactive
Operates Release From: Quabbin Winsor-Dam
IF Conditional
Flow < 4650
Description:
Add Cond.
Value1
Value2
Connecticut at Montague:Flow
<
4650
Del. Cond.
Move Up
Move Down
Evaluate
Logical Operator:
Value 1
Constant
Ope...
Value 2
Constant


Operation Set
Existing Ops
Description
War Department memos from the 1920's give a 1-June-through-30-Novembe
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Flood Control
Minimum flow to Swift River
Conservation
Maintain Navigation on Connecticut River at Montague
IF (Jun thru Nov)
Connecticut River flow <4650 cfs
IF (Flow < 4650)
Release min 110 cfs
ELSE IF (Flow < 4900 cfs)
Release min 70 cfs
ELSE (Flow >4900 cfs)
Minimum flow to Swift River
ELSE (Rest of year)
Minimum Release
Min Water Supply Intake
Inactive
Operates Release From: Quabbin Winsor-Dam
Rule Name:
Release min 110 cfs
Description:
Function of:
Date
Define...
Limit Type:
Mini...
Interp.:
Li...
Date
Release (cfs)
01Jan
110.0
111.0
110.5
110.0
109.5
109.0
Release (cfs)
Jan
Mar
May
Jul
Sep
Nov
Period Average Limit
Edit...
Hour of Day Multiplier
Edit...
Day of Week Multiplier
Edit...
Rising/Falling Condition
Edit...
Seasonal Variation
Edit...


Operation Set
Existing Ops
Description
War Department memos from the 1920's give a 1-June-through-30-Novembe
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Flood Control
Minimum flow to Swift River
Conservation
{ } Maintain Navigation on Connecticut River at Montague
IF (Jun thru Nov)
{ } Connecticut River flow <4650 cfs
IF (Flow < 4650)
Release min 110 cfs
ELSE IF (Flow < 4900 cfs)
Release min 70 cfs
ELSE (Flow >4900 cfs)
Minimum flow to Swift River
ELSE (Rest of year)
Minimum Release
Min Water Supply Intake
Inactive
Operates Release From: Quabbin Winsor-Dam
ELSE IF Conditional
Flow < 4900 cfs
Description:
Value1
Value2
Connecticut at Montague:Flow
>=
4650
AND
Connecticut at Montague:Flow
<
4900
Add Cond.
Del. Cond.
Move Up
Move Down
Evaluate
Logical Operator:
Value 1
Constant
Ope...
Value 2
Constant


Operation Set
Existing Ops
Description
War Department memos from the 1920's give a 1-June-through-30-Novembe
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Flood Control
Minimum flow to Swift River
Conservation
{ } Maintain Navigation on Connecticut River at Montague
IF (Jun thru Nov)
{ } Connecticut River flow <4650 cfs
IF (Flow < 4650)
Release min 110 cfs
ELSE IF (Flow < 4900 cfs)
Release min 70 cfs
ELSE (Flow >4900 cfs)
Minimum flow to Swift River
ELSE (Rest of year)
Minimum Release
Min Water Supply Intake
Inactive
Operates Release From: Quabbin Winsor-Dam
Rule Name:
Release min 70 cfs
Description:
Function of:
Date
Define...
Limit Type:
Mini...
Interp.:
Li...
Date
Release (cfs)
01Jan
70.0
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...


Operation Set
Existing Ops
Description
War Department memos from the 1920's give a 1-June-through-30-Novembe
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Flood Control
Minimum flow to Swift River
Conservation
{ } Maintain Navigation on Connecticut River at Montague
IF (Jun thru Nov)
{ } Connecticut River flow <4650 cfs
IF (Flow < 4650)
Release min 110 cfs
ELSE IF (Flow < 4900 cfs)
Release min 70 cfs
ELSE (Flow >4900 cfs)
Minimum flow to Swift River
ELSE (Rest of year)
Minimum Release
Min Water Supply Intake
Inactive
Operates Release From: Quabbin Winsor-Dam
ELSE Conditional
Flow >4900 cfs
Description:


Operation Set
Existing Ops
Description
War Department memos from the 1920's give a 1-June-through-30-Novembe
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Flood Control
Minimum flow to Swift River
Conservation
{ } Maintain Navigation on Connecticut River at Montague
IF (Jun thru Nov)
{ } Connecticut River flow <4650 cfs
IF (Flow < 4650)
Release min 110 cfs
ELSE IF (Flow < 4900 cfs)
Release min 70 cfs
ELSE (Flow >4900 cfs)
Minimum flow to Swift River
ELSE (Rest of year)
Minimum Release
Min Water Supply Intake
Inactive
Operates Release From: Quabbin Winsor-Dam
Rule Name:
linimum flow to Swift River
Description:
Function of:
Date
Define...
Limit Type:
Speci...
Interp.:
Li...
Date
Release (cfs)
01Jan 30.0
31May 30.0
01Jun 94.0
30Jun 94.0
01Jul 30.0
31Dec 30.0
Release (cfs)
100
80
60
40
20
Jan
Mar
May
Jul
Sep
Nov
Period Average Limit
Hour of Day Multiplier
Day of Week Multiplier
Rising/Falling Condition
Seasonal Variation
Edit...

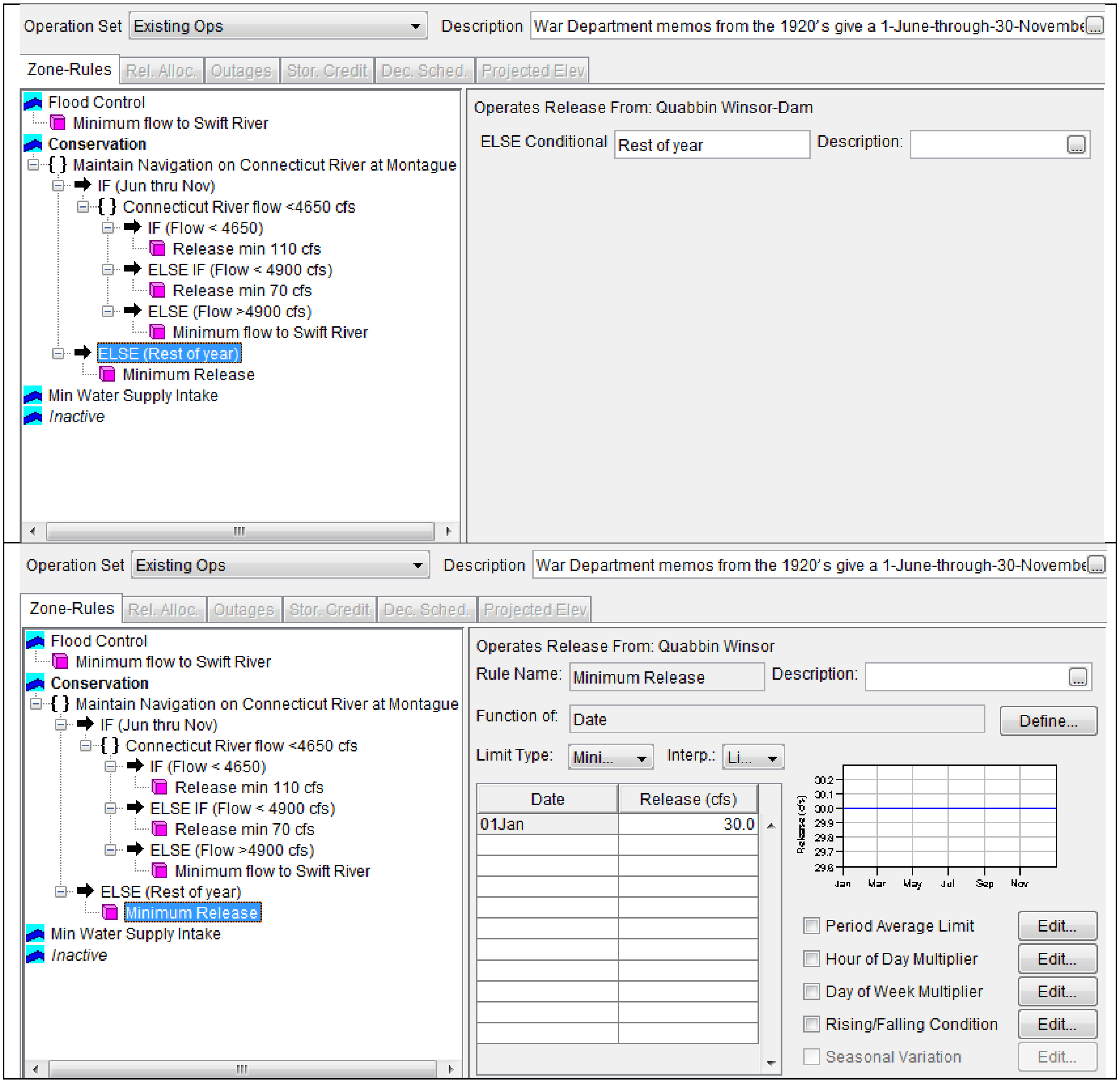


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maintain Navigation at Connecticut River at Montague

Rainbow

I. Overview

Rainbow Dam is located in the town of Rainbow, CT on the Farmington River. It is owned and operated by the Farmington River Power Company and is used for hydropower generation.

Figure 1 shows the location of Rainbow Dam as it is represented in the HEC-ResSim model. Figure 2 shows the photo of Rainbow Dam.

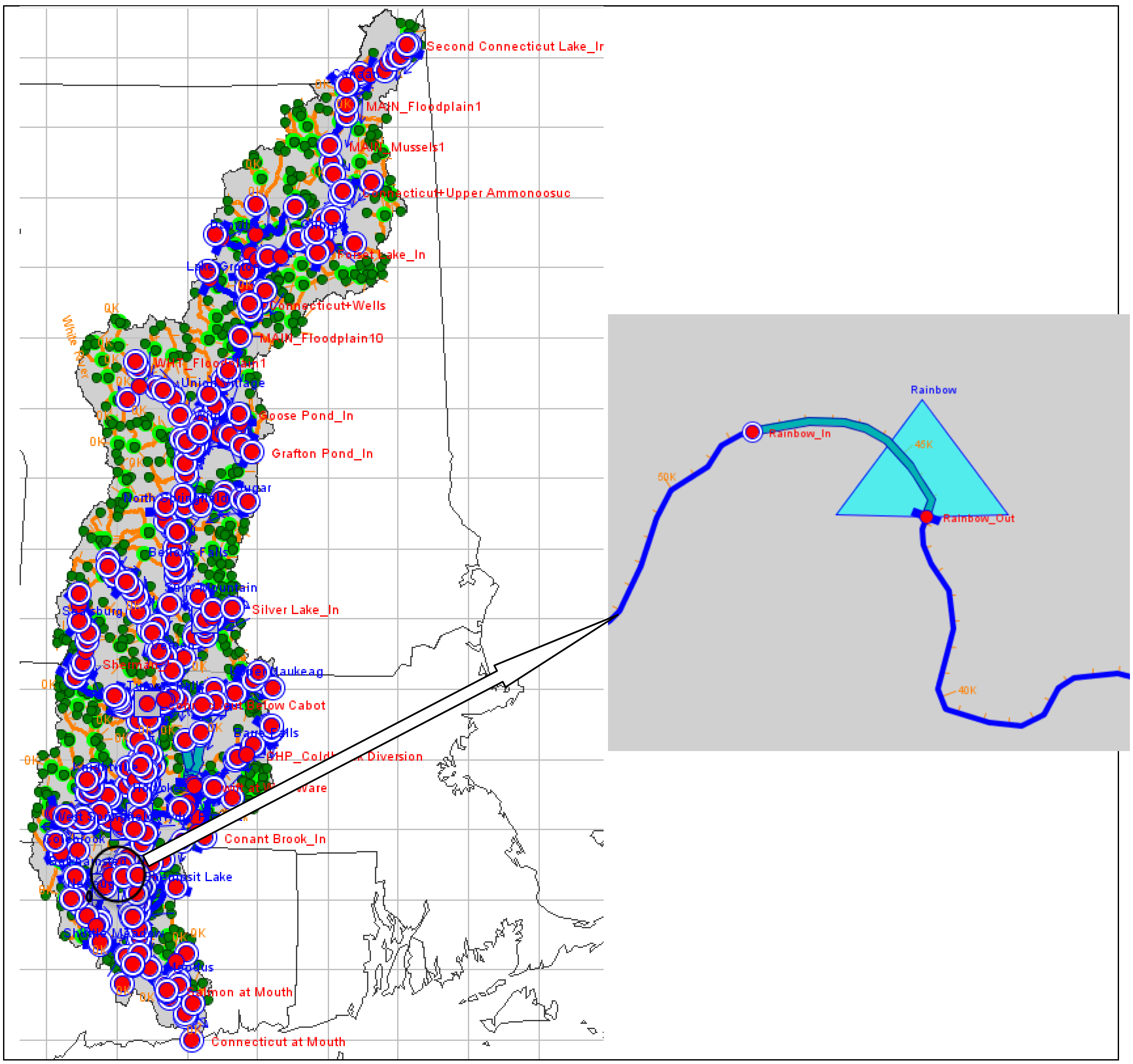


Figure 1: HEC-ResSim Map Display Showing Location of Rainbow

Figure 2: Photo of Rainbow Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[80]. The dam consists of three types of outlets: (1) controlled sluice gates, (2) controlled spillway, and (3) power plant as shown in Figure 4.

[80] Data provided by UMASS

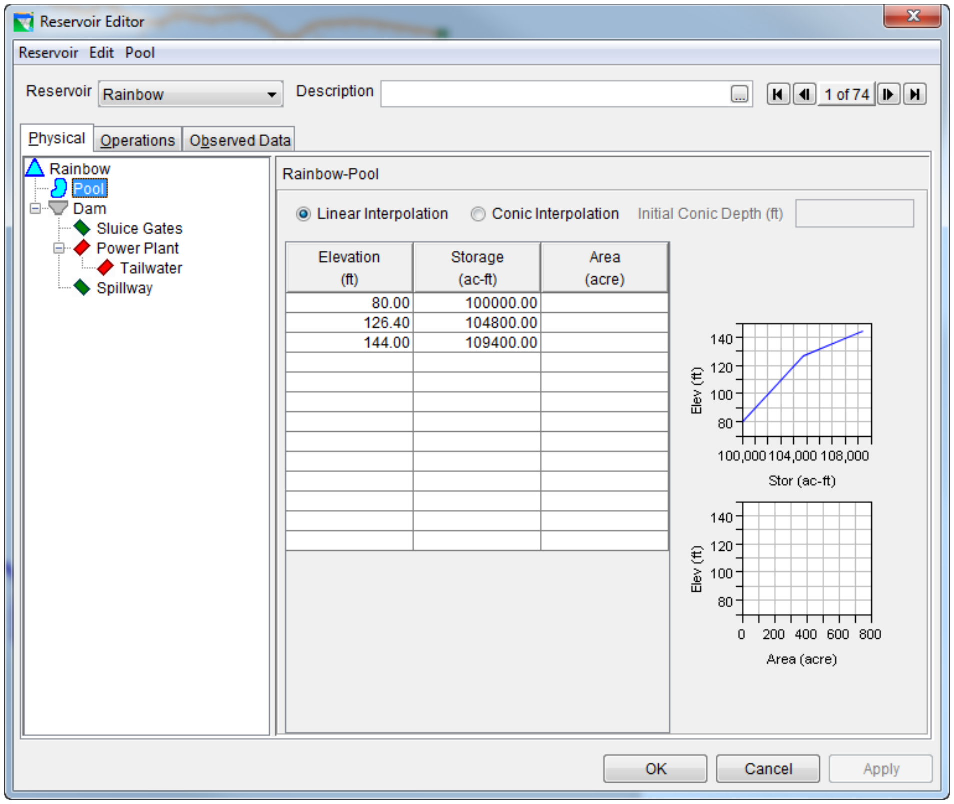


Figure 3: Reservoir Editor: Physical Tab -- Pool

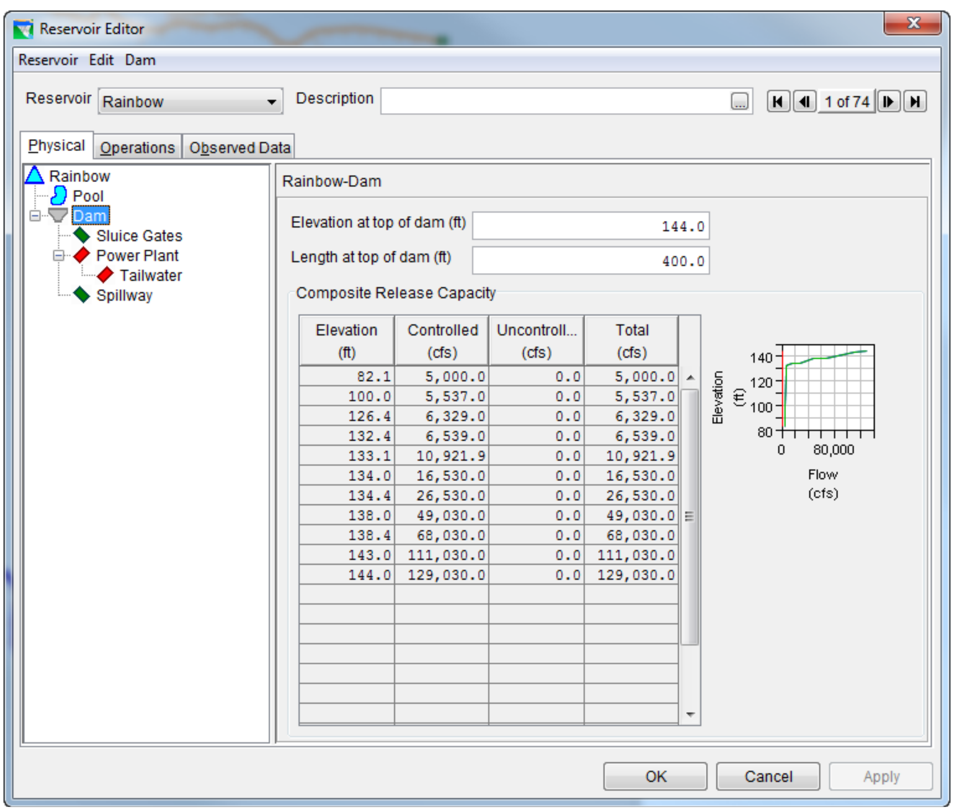


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Raibow's "Existing Ops" operational zones, which consist of zones of Top of dam (144 ft), Conservation (132.4 ft), and Inactive zone (86 ft).

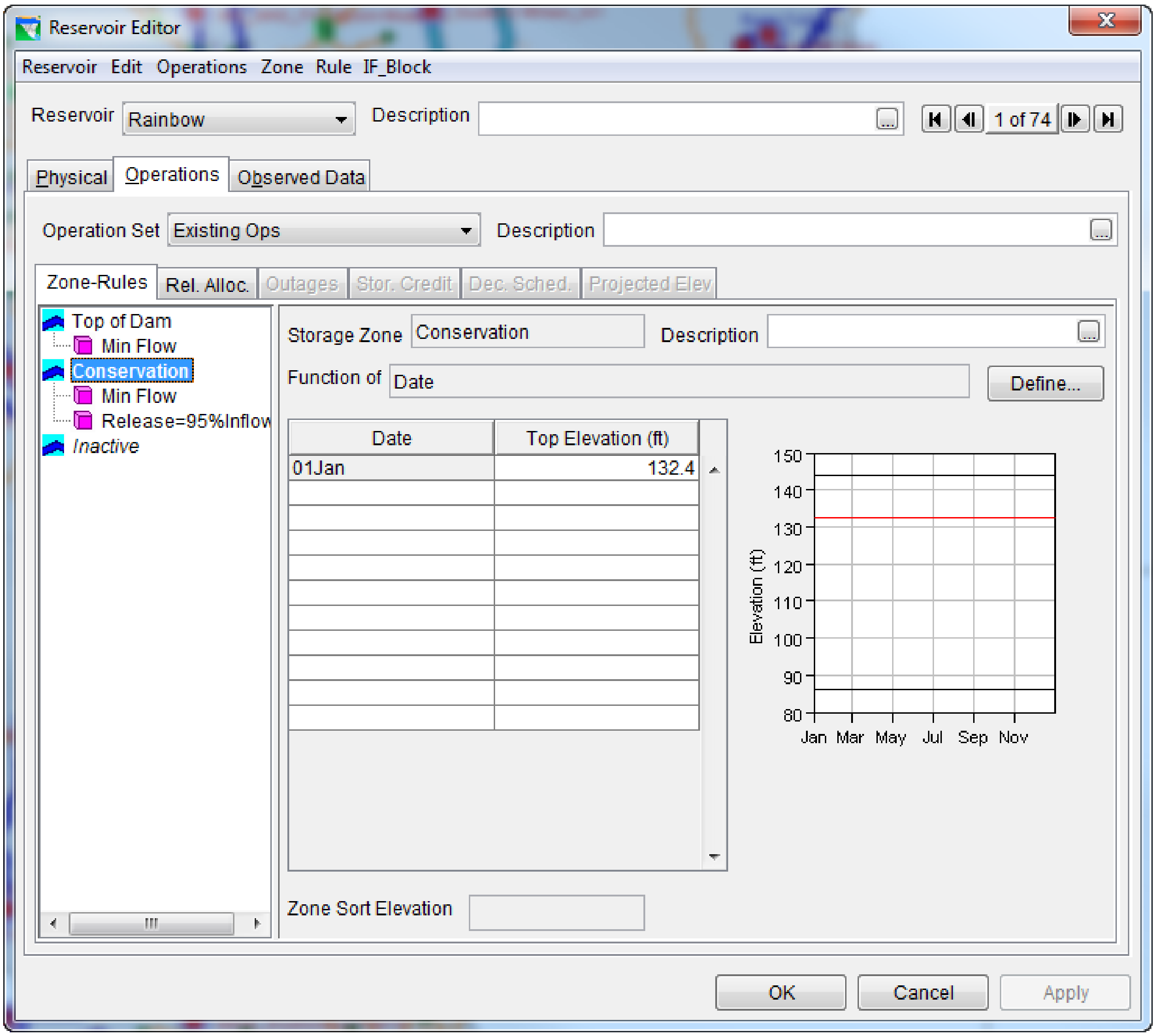


Figure 5: Reservoir Editor: Operations Tab – Existing Ops OpSet

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

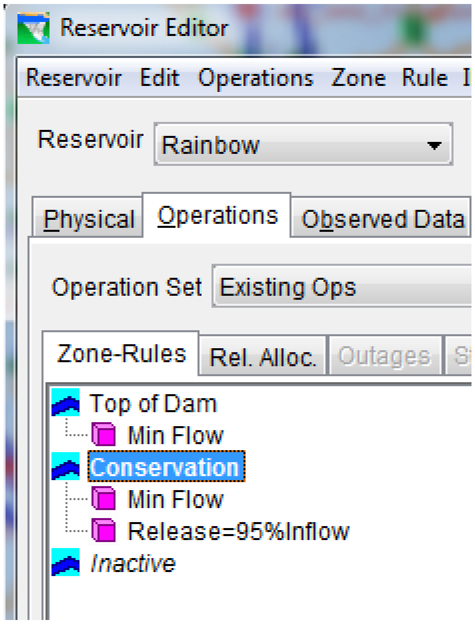


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Min Flow

Figure 7 shows the content of "Min flow" rule. This rule represents the minimum release from Dam as a function of date.

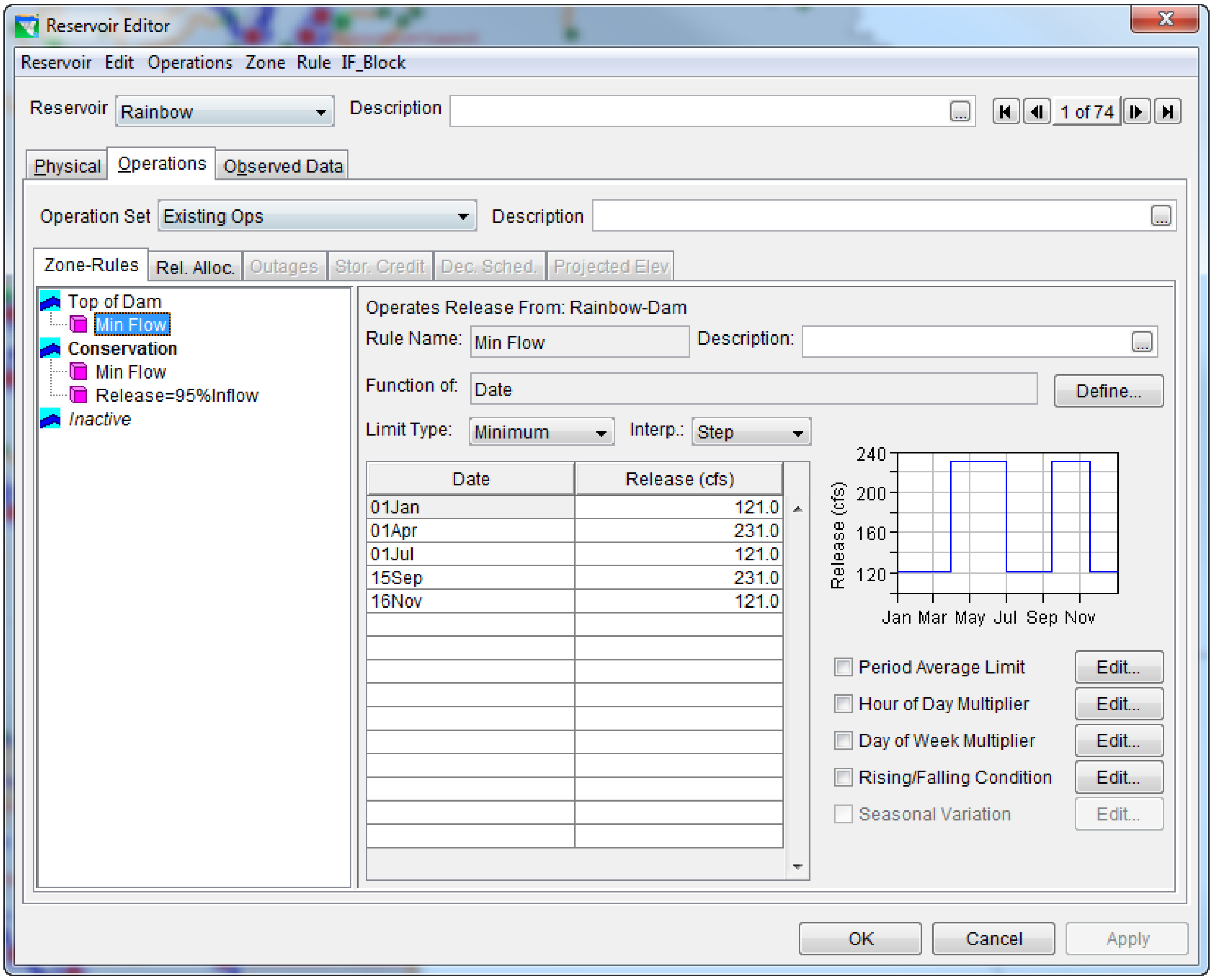


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow

2. Release=95%Inflow

Figure 8 shows the content of “Release=95%Inflow” rule. This rule represents the minimum release from Rainbow as a function of inflow as per the run-of-river modeling strategy.

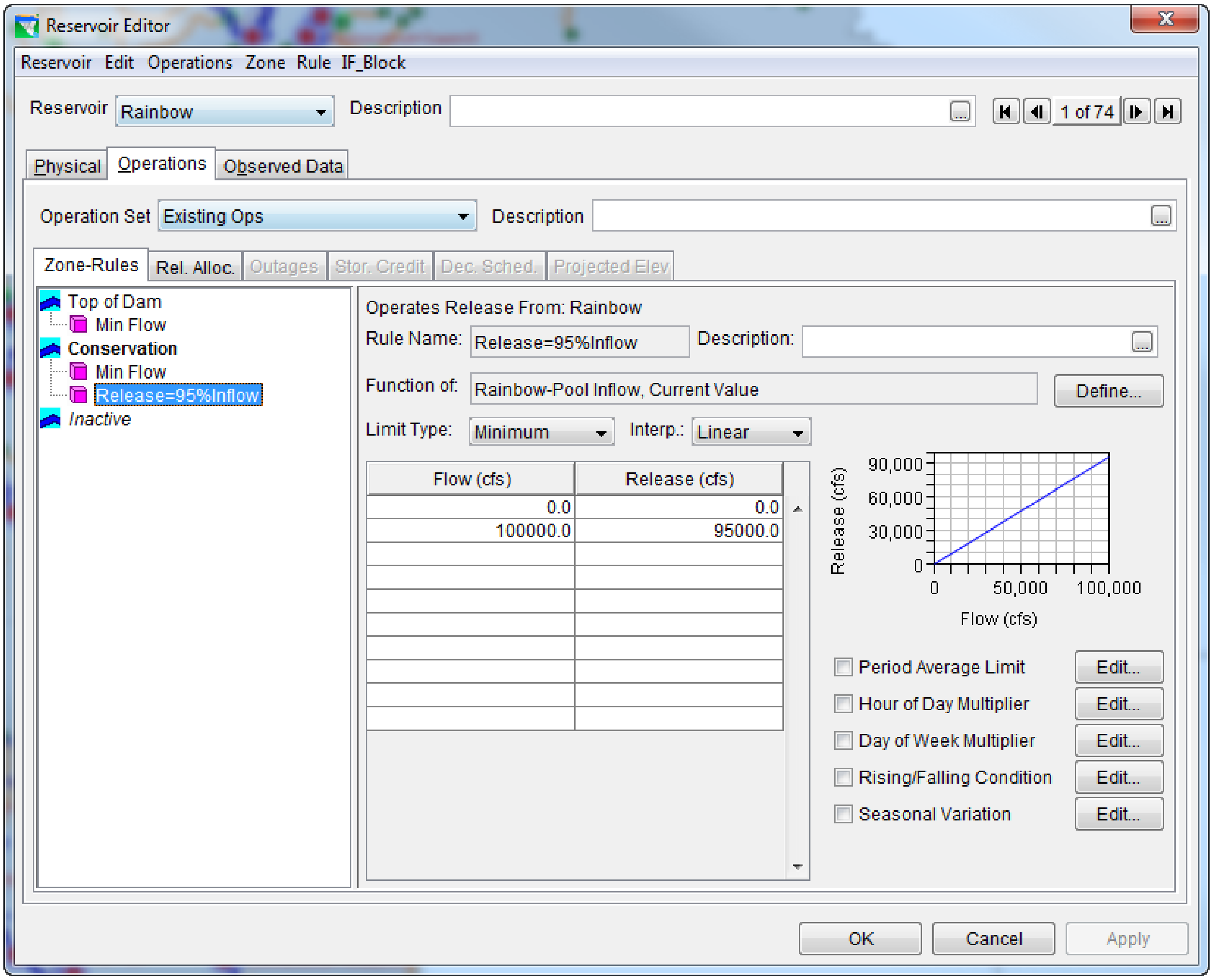


Figure 8 Reservoir Editor: Operations Tab – Existing Ops OpSet – Release=95%Inflow

Red Bridge

I. Overview

Red Bridge dam is located in the towns of Wilbraham and Ludlow, MA on the Chicopee River. It is owned and operated by Essential Power LLC and is operated as run-of-river hydropower generating facility.

Figure 1 shows the location of Red Bridge dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Red Bridge dam.

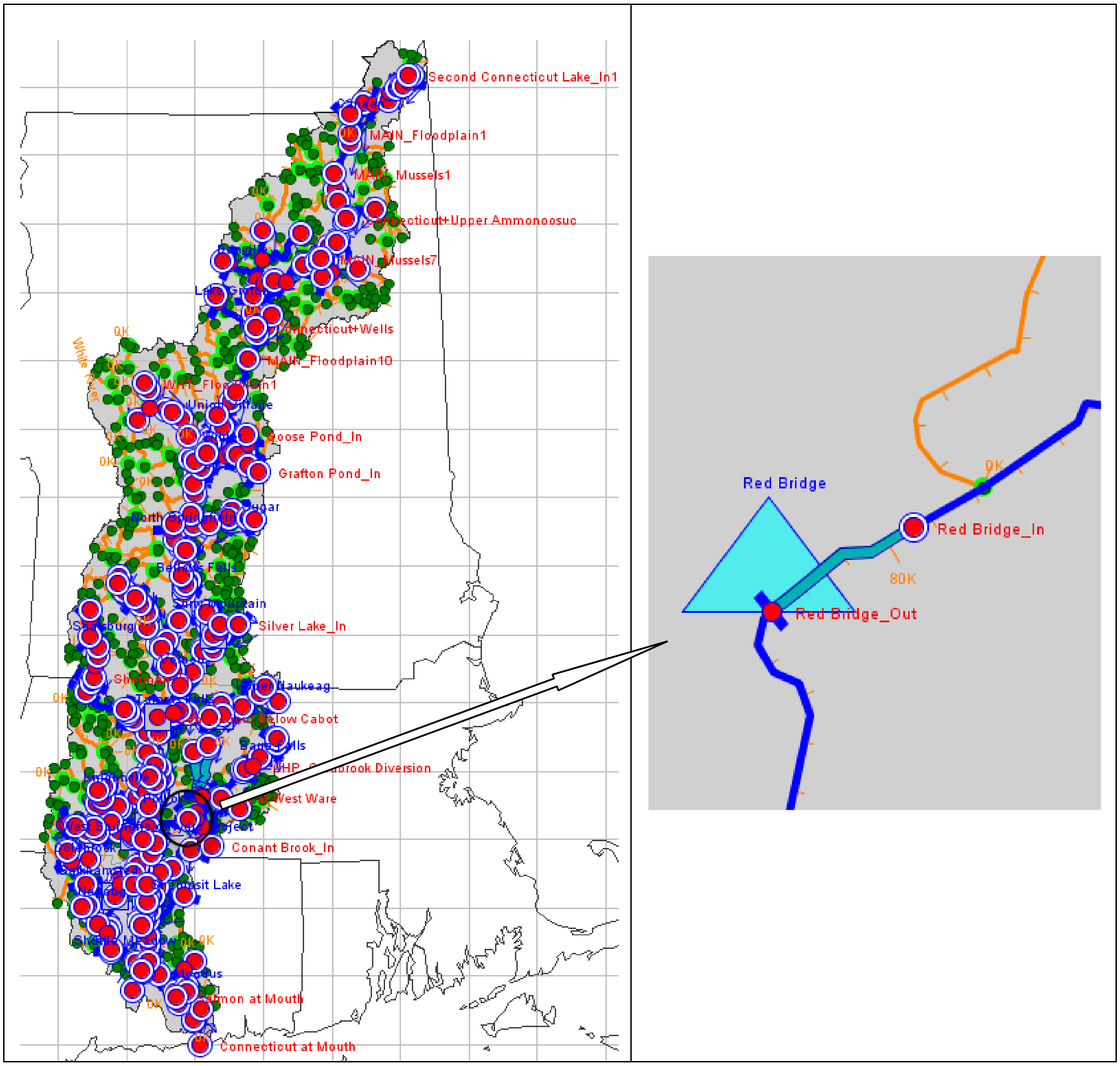


Figure 1: HEC-ResSim Map Display Showing Location of Red Bridge Dam

Figure 2: Photo of Red Bridge dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[81]. The dam consists of two types of outlets: (1) uncontrolled outlet and (3) power plant as shown in Figure 4 [1,82]. The capacity of the power plant was made to be the maximum release specified in the NID database so that the dam would modeled completely as run-of-river with some actual physical information

[81] National Inventory of Dams database (NID)

[82] http://www.lowimpacthydro.org/lihi-certificate-96-red-bridge-project-ma.html

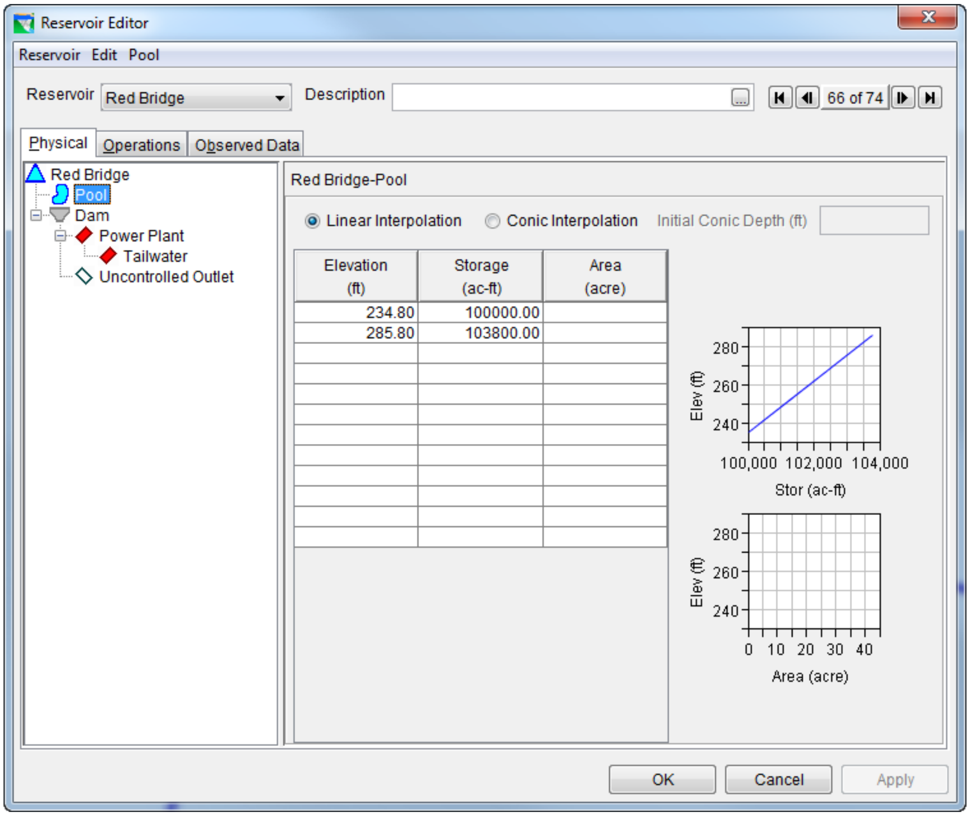


Figure 3: Reservoir Editor: Physical Tab – Pool

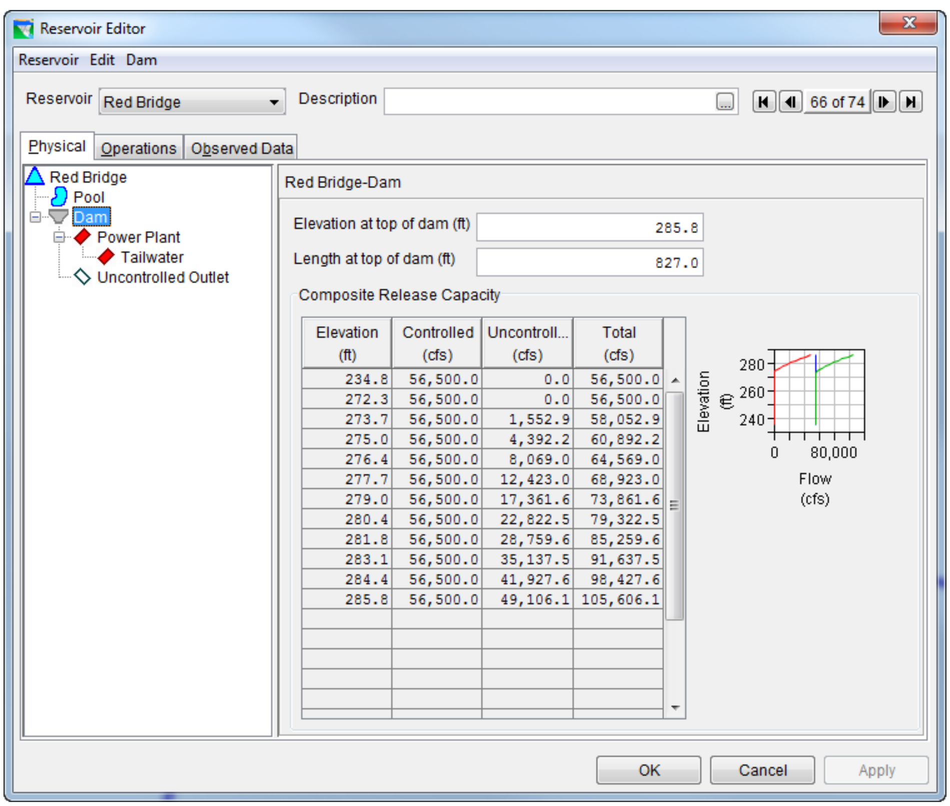


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Red Bridge's "Guide Curve" operational zones, which consist of Top of Dam (285.8 ft), Conservation (271.3 ft), and Inactive zone (235.8 ft)[2].

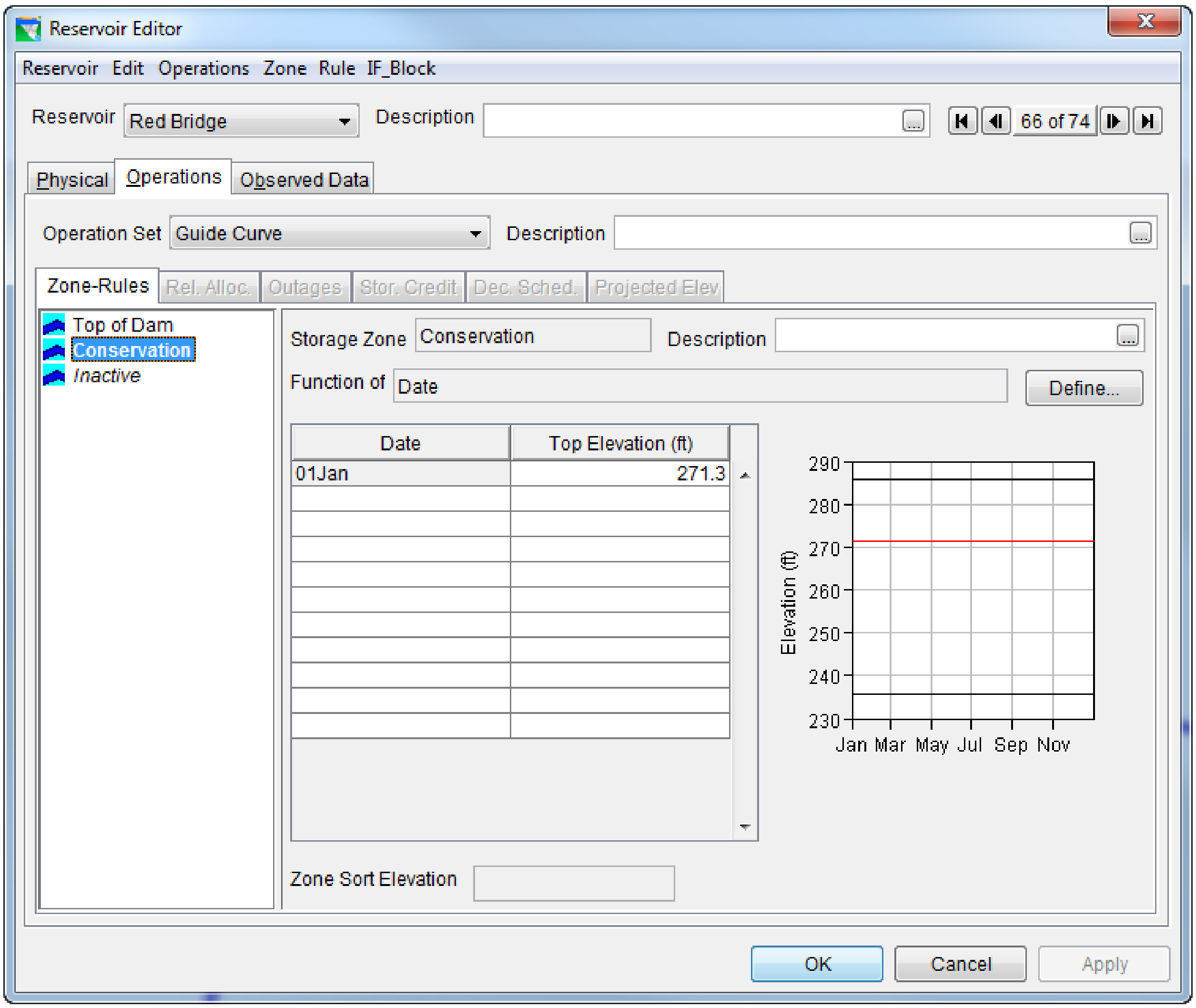


Figure 5: Reservoir Editor: Operations Tab –Guide Curve OpSet – Guide Curve

B. Rule Illustrations

The operation set for Red Bridge has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity. This was modeled this way because no real operation information was found.

Searsburg

I. Overview

Searsburg dam is located on the Deerfield River upstream of Harriman. It is owned and operated by TransCanada Hydro Northeast Inc. for hydropower generation on a peaking, seasonal storage basis.

Figure 1 shows the location of Searsburg Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo from Searsburg Dam.

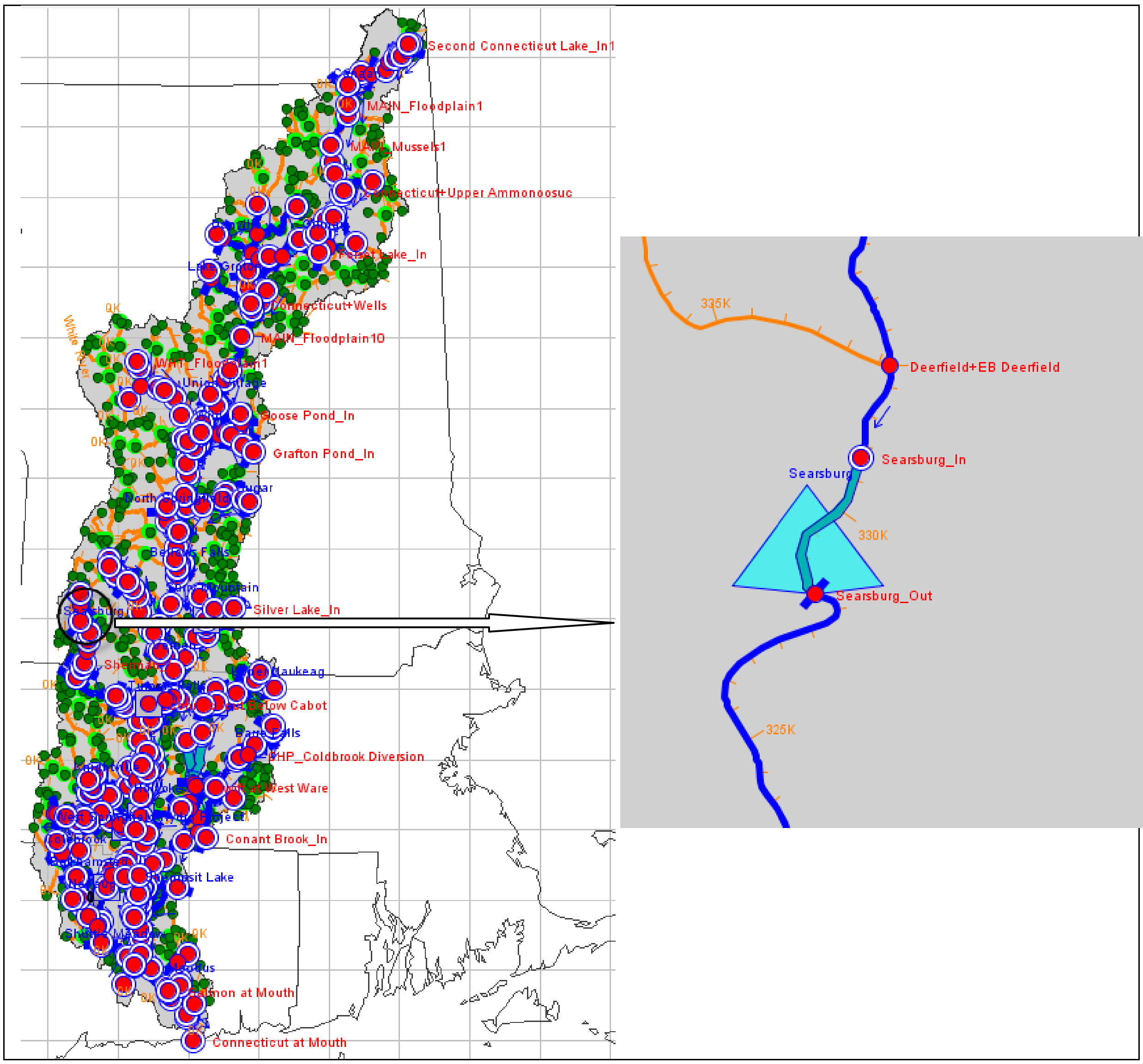


Figure 1: HEC-ResSim Map Display Showing Location of Searsburg dam

Figure 2: Photo of Searsburg Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[83]. The dam consists of five types of outlets: (1) controlled sluice, (2) controlled waste gate, (3) uncontrolled spillway over 5ft flashboards, (4) spillway over clear crest, and (5) power plant as shown in Figure 4.

.

[83] Data provided by TransCanada

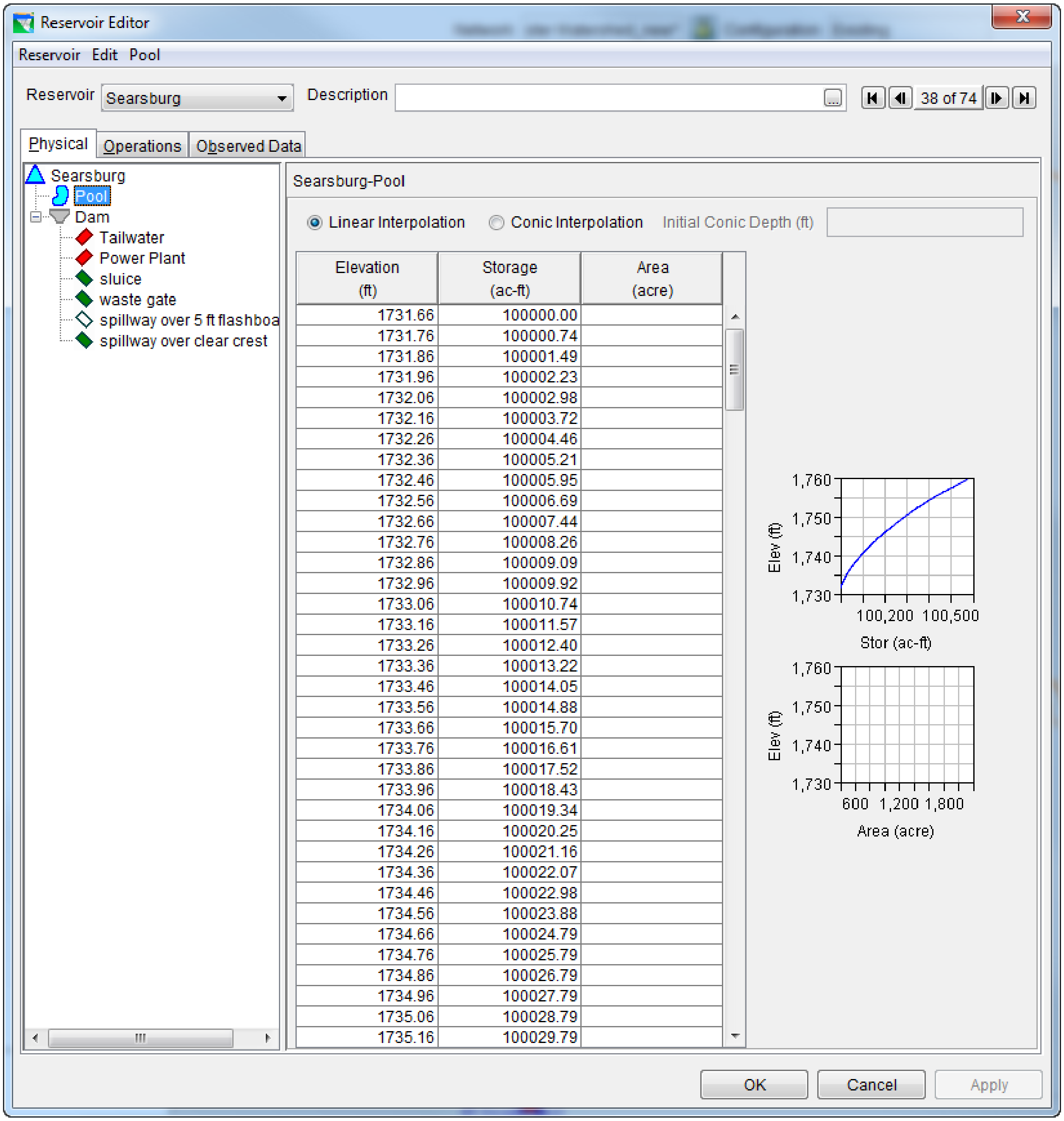
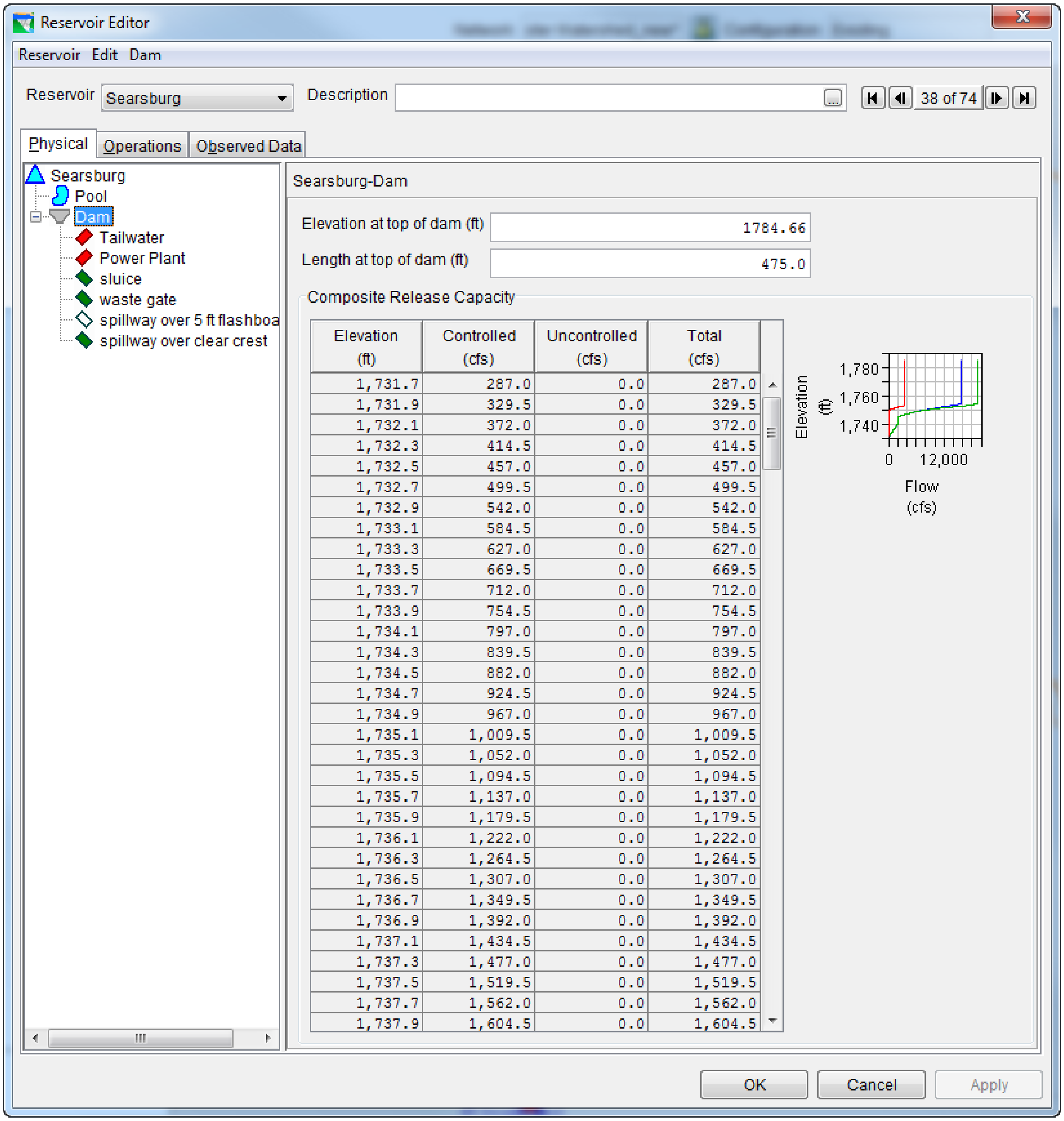


Figure 3: Reservoir Editor: Physical Tab -- Pool



Elevation (ft)	Controlled (cfs)	Uncontrolled (cfs)	Total (cfs)
1,731.7	287.0	0.0	287.0
1,731.9	329.5	0.0	329.5
1,732.1	372.0	0.0	372.0
1,732.3	414.5	0.0	414.5
1,732.5	457.0	0.0	457.0
1,732.7	499.5	0.0	499.5
1,732.9	542.0	0.0	542.0
1,733.1	584.5	0.0	584.5
1,733.3	627.0	0.0	627.0
1,733.5	669.5	0.0	669.5
1,733.7	712.0	0.0	712.0
1,733.9	754.5	0.0	754.5
1,734.1	797.0	0.0	797.0
1,734.3	839.5	0.0	839.5
1,734.5	882.0	0.0	882.0
1,734.7	924.5	0.0	924.5
1,734.9	967.0	0.0	967.0
1,735.1	1,009.5	0.0	1,009.5
1,735.3	1,052.0	0.0	1,052.0
1,735.5	1,094.5	0.0	1,094.5
1,735.7	1,137.0	0.0	1,137.0
1,735.9	1,179.5	0.0	1,179.5
1,736.1	1,222.0	0.0	1,222.0
1,736.3	1,264.5	0.0	1,264.5
1,736.5	1,307.0	0.0	1,307.0
1,736.7	1,349.5	0.0	1,349.5
1,736.9	1,392.0	0.0	1,392.0
1,737.1	1,434.5	0.0	1,434.5
1,737.3	1,477.0	0.0	1,477.0
1,737.5	1,519.5	0.0	1,519.5
1,737.7	1,562.0	0.0	1,562.0
1,737.9	1,604.5	0.0	1,604.5

Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Searsburg's "ExistingOps" operational zones, which consist of zones of Top of dam (1784.66 ft), conservation (1754.66 ft), Min Pool (1743.66-1746.66 ft), Buffer Inactive (1720 ft), and Inactive zone (1704.6 ft)[1].

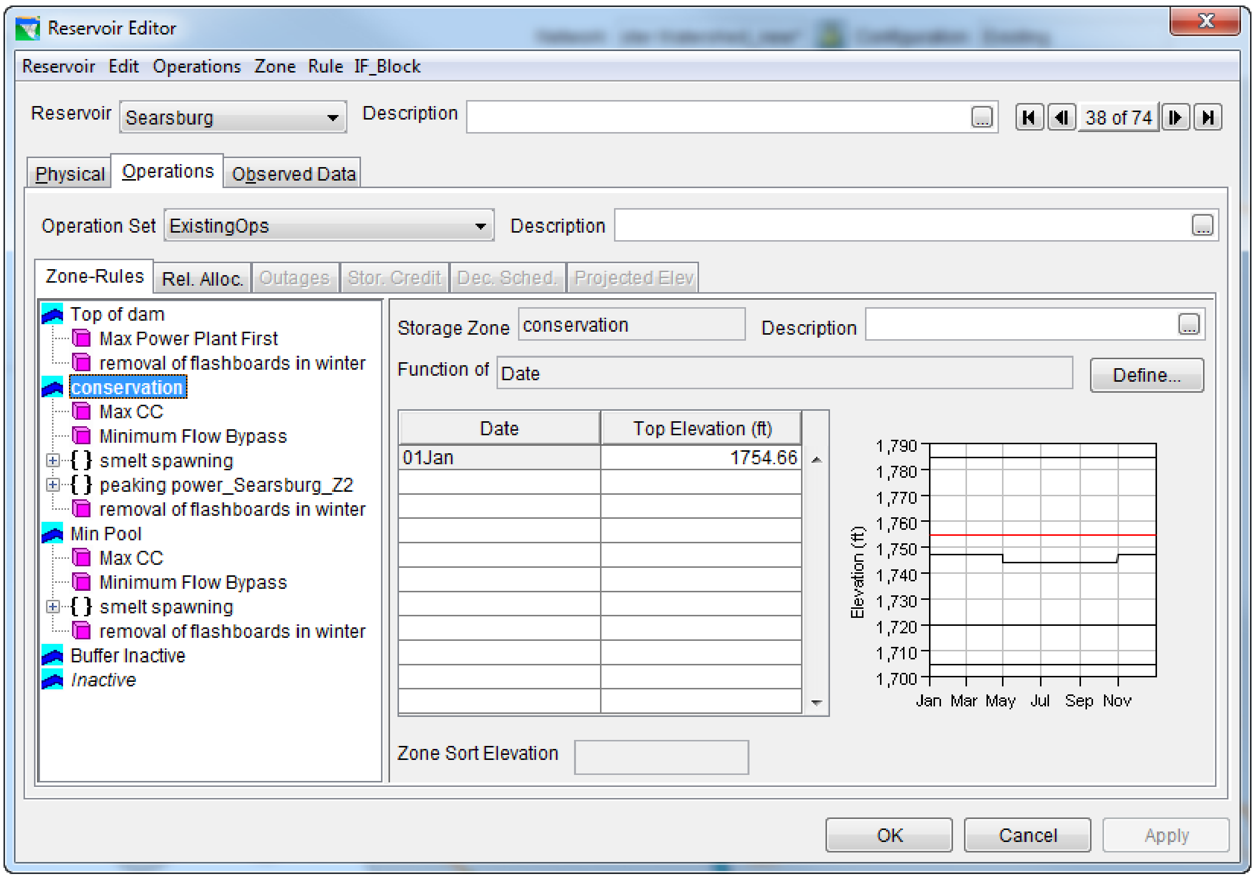


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Harriman Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The sluice gets the remainder of the release until it reaches capacity. After the capacity through the sluice is reached, the remainder of the release goes through the waste gate and the rest is passing through the spillway over the clear crest.

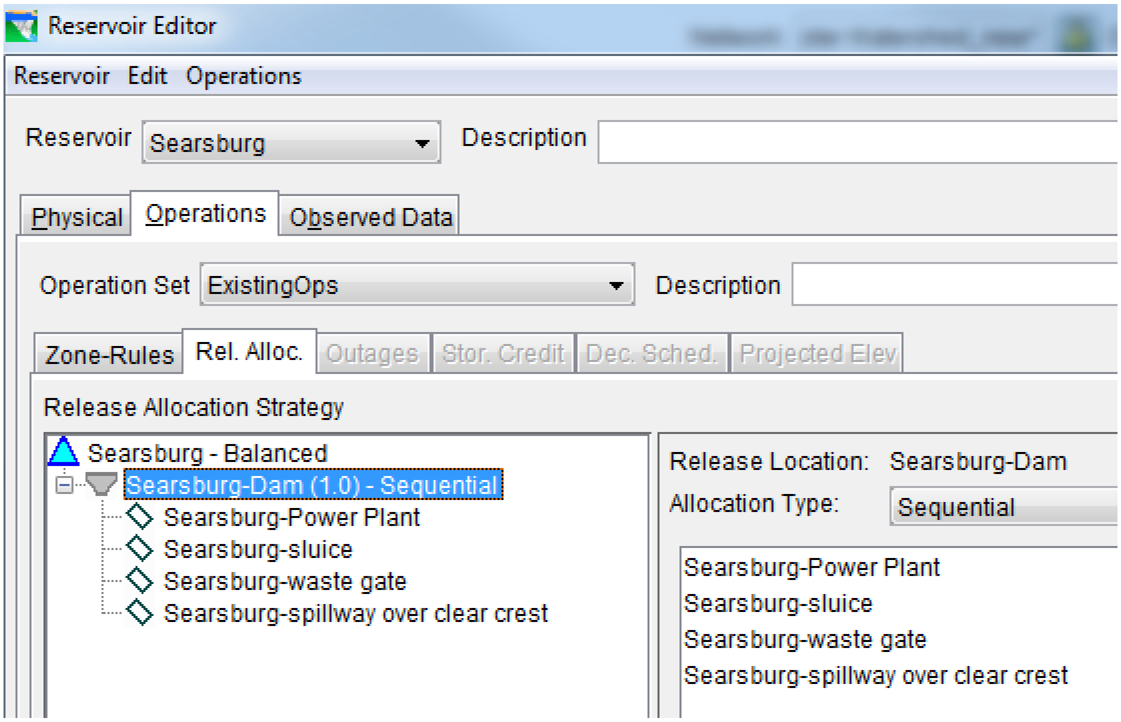


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops (TransCanada Corporation).

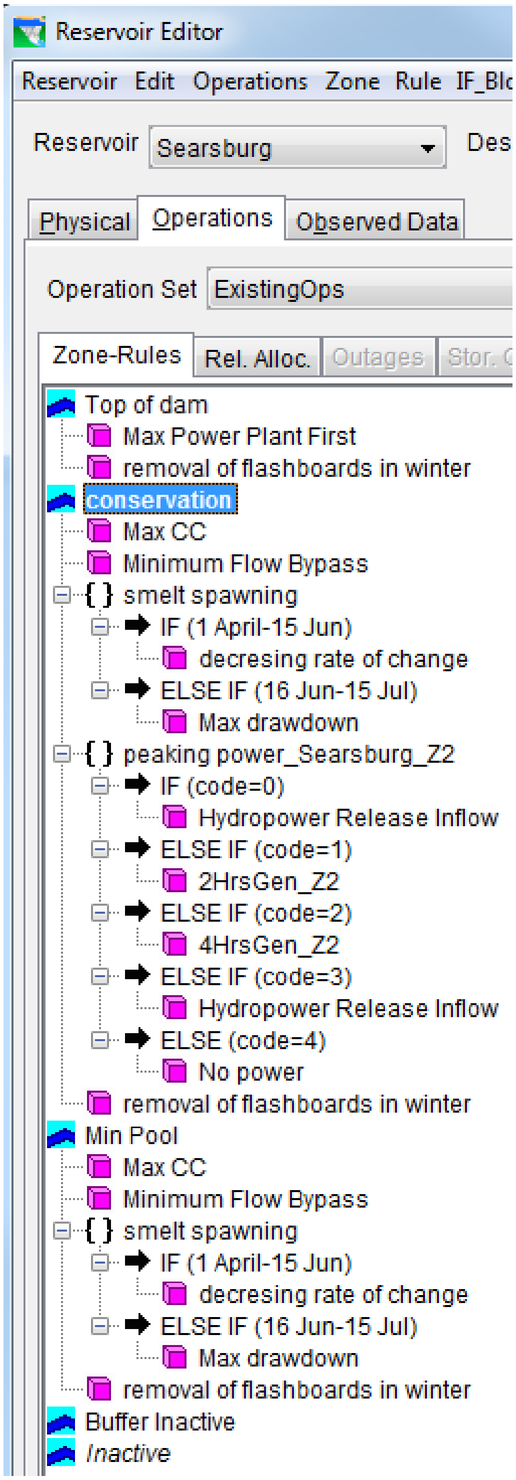


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Max Power Plant First

Figure 8 shows the content of “Max Power Plant First” rule. This rule forces the inflow to pass through the power plant first until it reaches the maximum plant capacity.

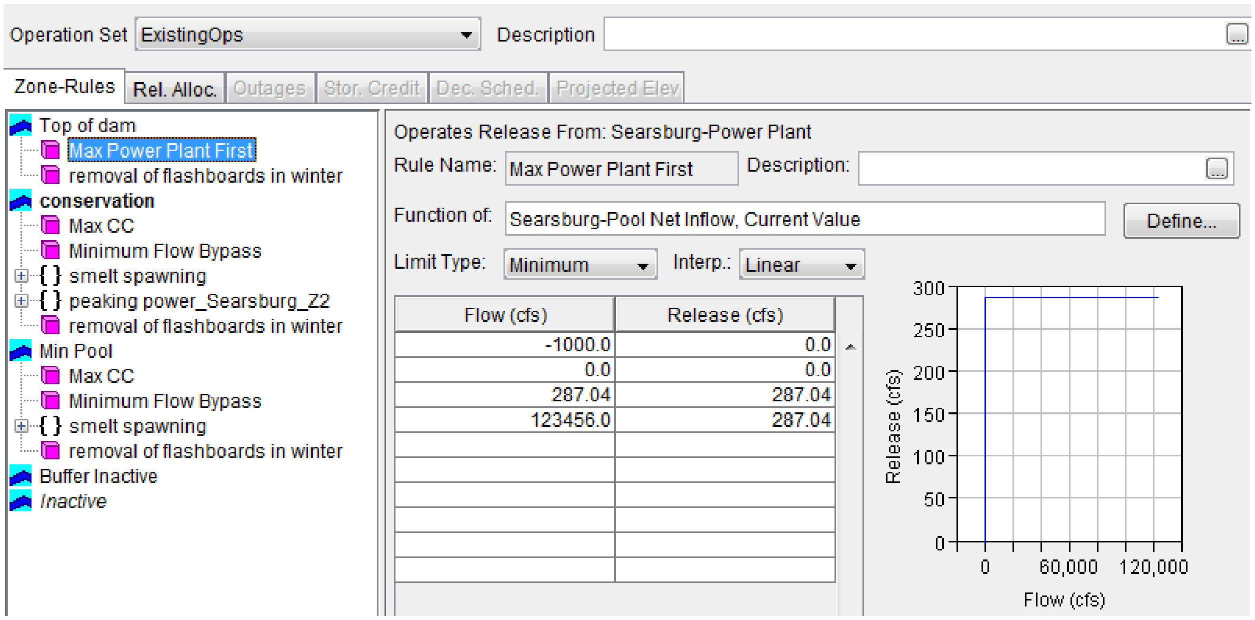
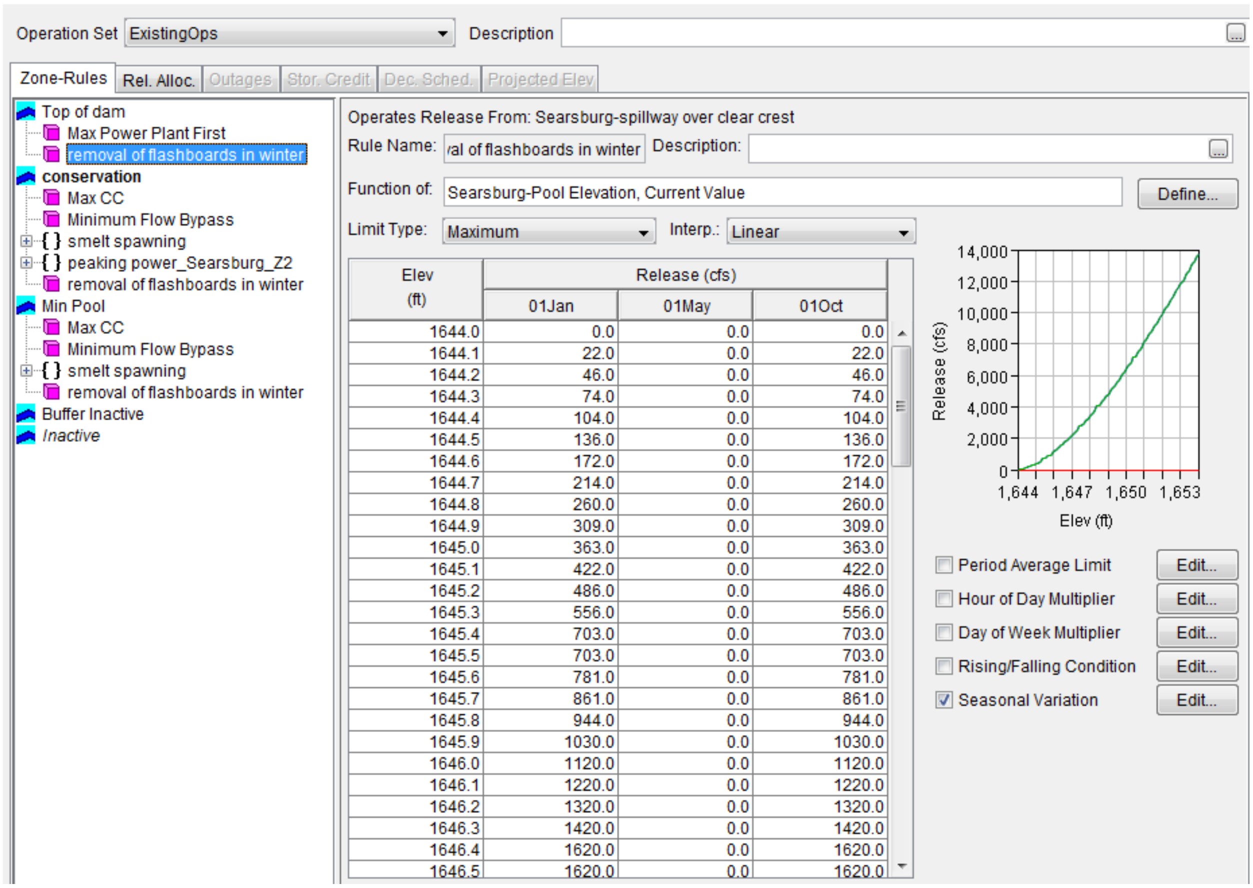


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Power Plant First

2. *Removal of flashboards in winter*

Figure 9 shows the content of "removal of flashboards in winter" rule. This rule represents the releases through spillways when the flashboards are removed in winters.



Elev (ft)	Release (cfs) 01Jan	01May	01Oct
1644.0	0.0	0.0	0.0
1644.1	22.0	0.0	22.0
1644.2	46.0	0.0	46.0
1644.3	74.0	0.0	74.0
1644.4	104.0	0.0	104.0
1644.5	136.0	0.0	136.0
1644.6	172.0	0.0	172.0
1644.7	214.0	0.0	214.0
1644.8	260.0	0.0	260.0
1644.9	309.0	0.0	309.0
1645.0	363.0	0.0	363.0
1645.1	422.0	0.0	422.0
1645.2	486.0	0.0	486.0
1645.3	556.0	0.0	556.0
1645.4	703.0	0.0	703.0
1645.5	703.0	0.0	703.0
1645.6	781.0	0.0	781.0
1645.7	861.0	0.0	861.0
1645.8	944.0	0.0	944.0
1645.9	1030.0	0.0	1030.0
1646.0	1120.0	0.0	1120.0
1646.1	1220.0	0.0	1220.0
1646.2	1320.0	0.0	1320.0
1646.3	1420.0	0.0	1420.0
1646.4	1620.0	0.0	1620.0
1646.5	1620.0	0.0	1620.0

Figure 9 Reservoir Editor: Operations Tab – Existing Ops OpSet – removal of flashboards in winter

3. *Max CC*

Figure 10 represents the content of “Max CC” rule. This rule limits the channel capacity to 340 cfs.

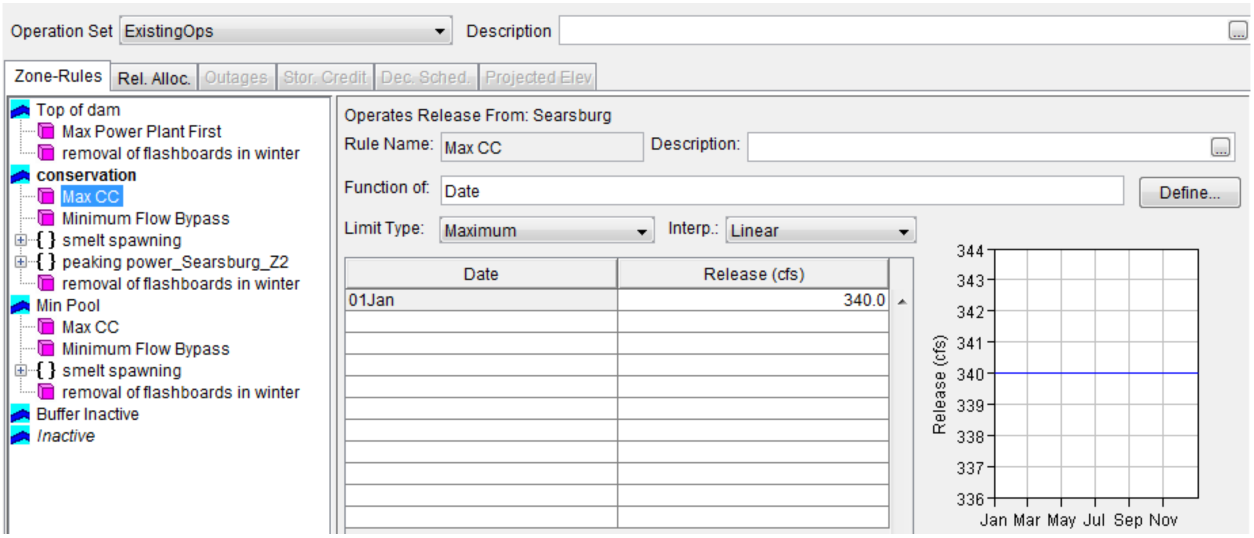


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max CC

4. *Minimum Flow Bypass*

Figure 11 shows the content of “Minimum Flow Bypass” which shows a seasonal minimum flow as a function of Inflow.

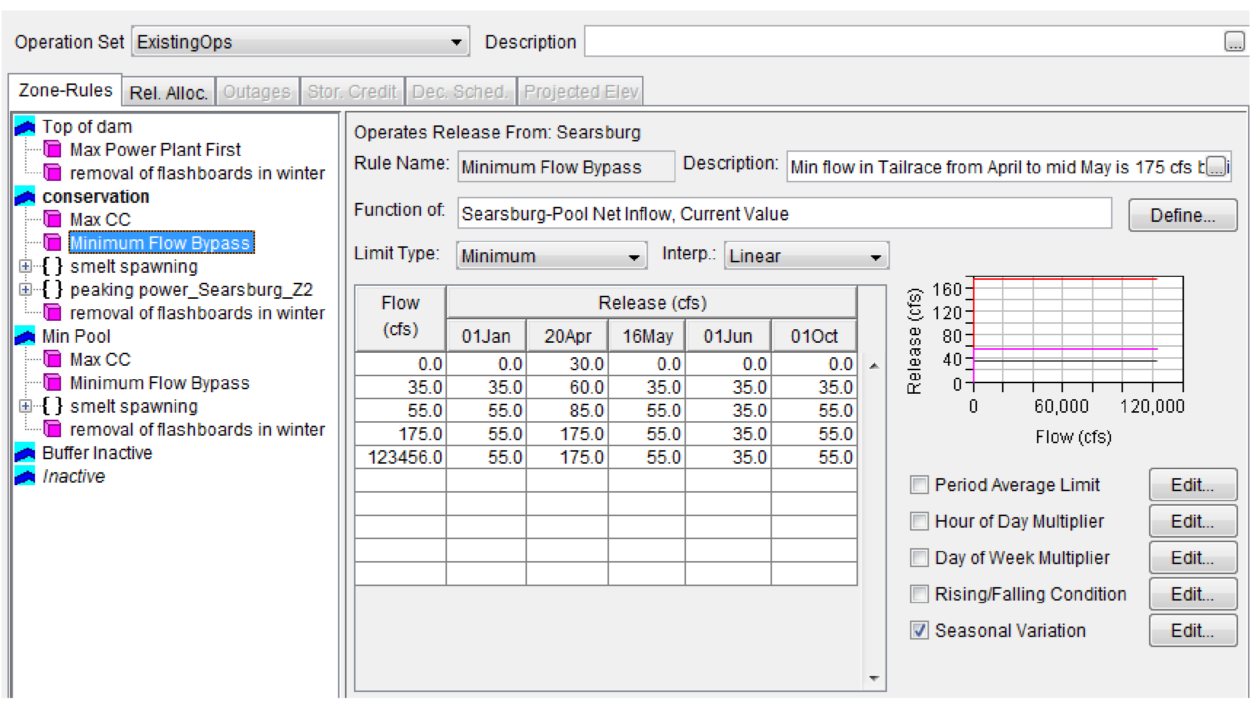
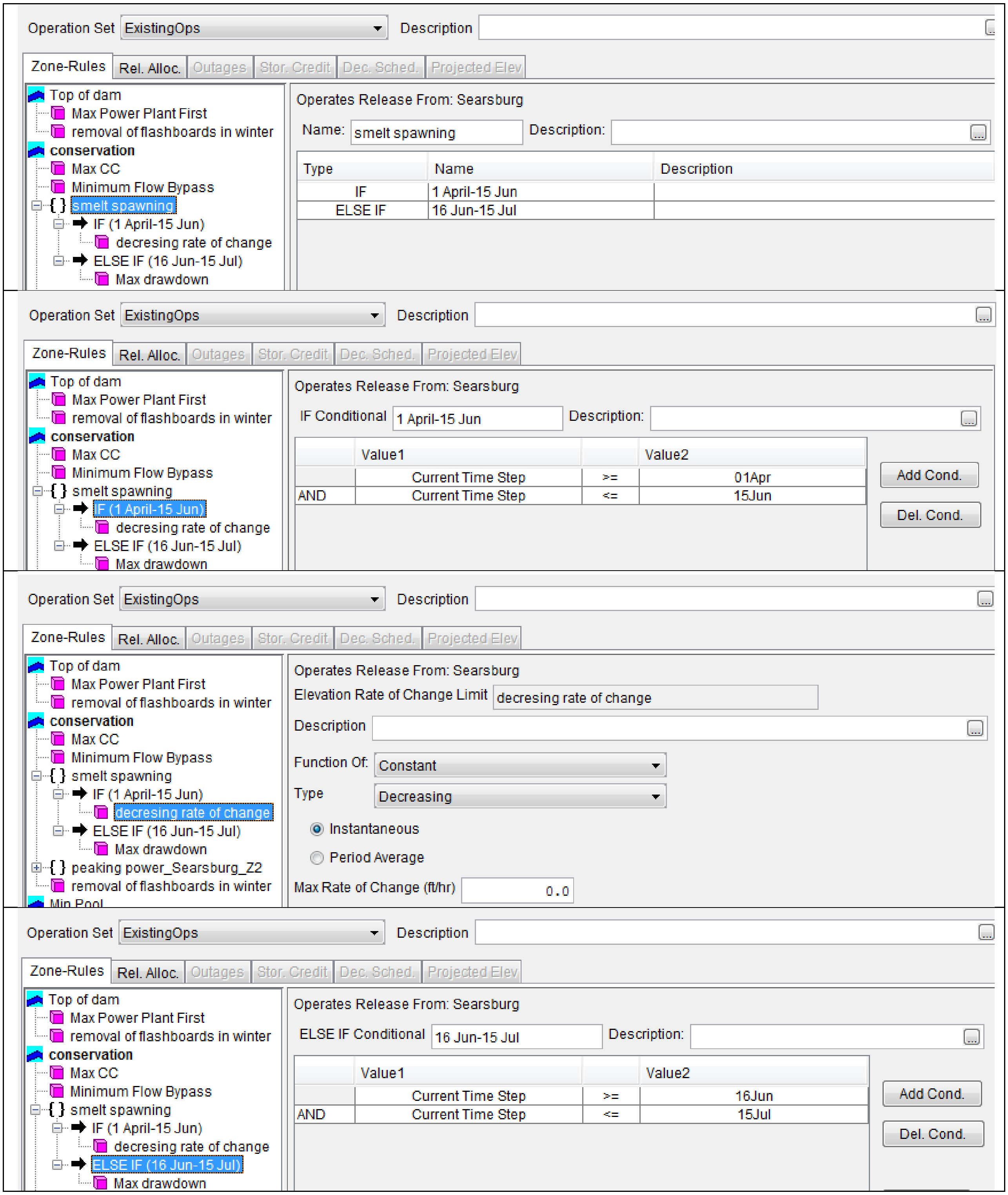


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Minimum Flow Bypass

5. *Smelt Spawning*

Figure 12 describes the content of "smelt spawning" rule. Based on this rule during Apr1-Jun 15 maximum rate of elevation change is zero, and during Jun 16-Jul 15 the maximum rate of change is one ft/hr.



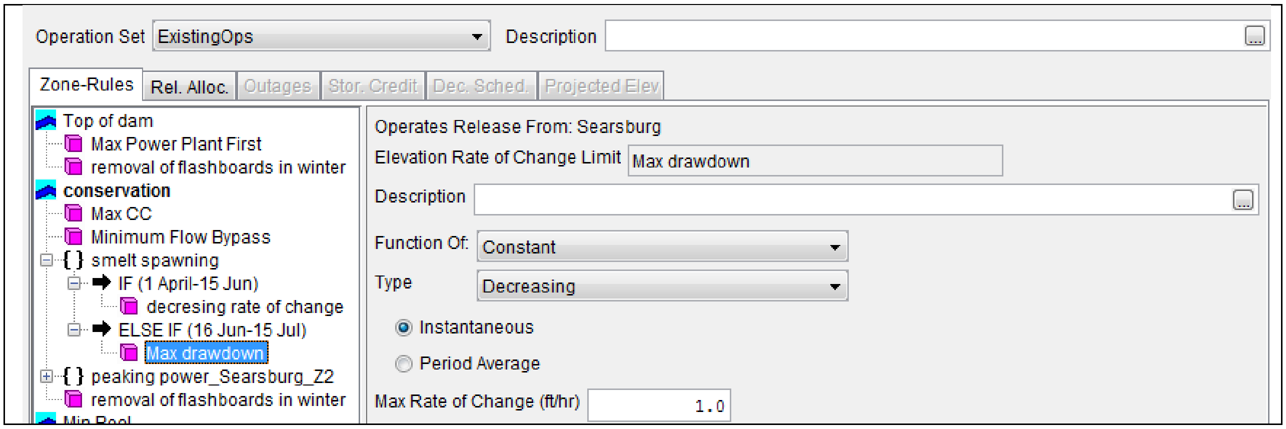
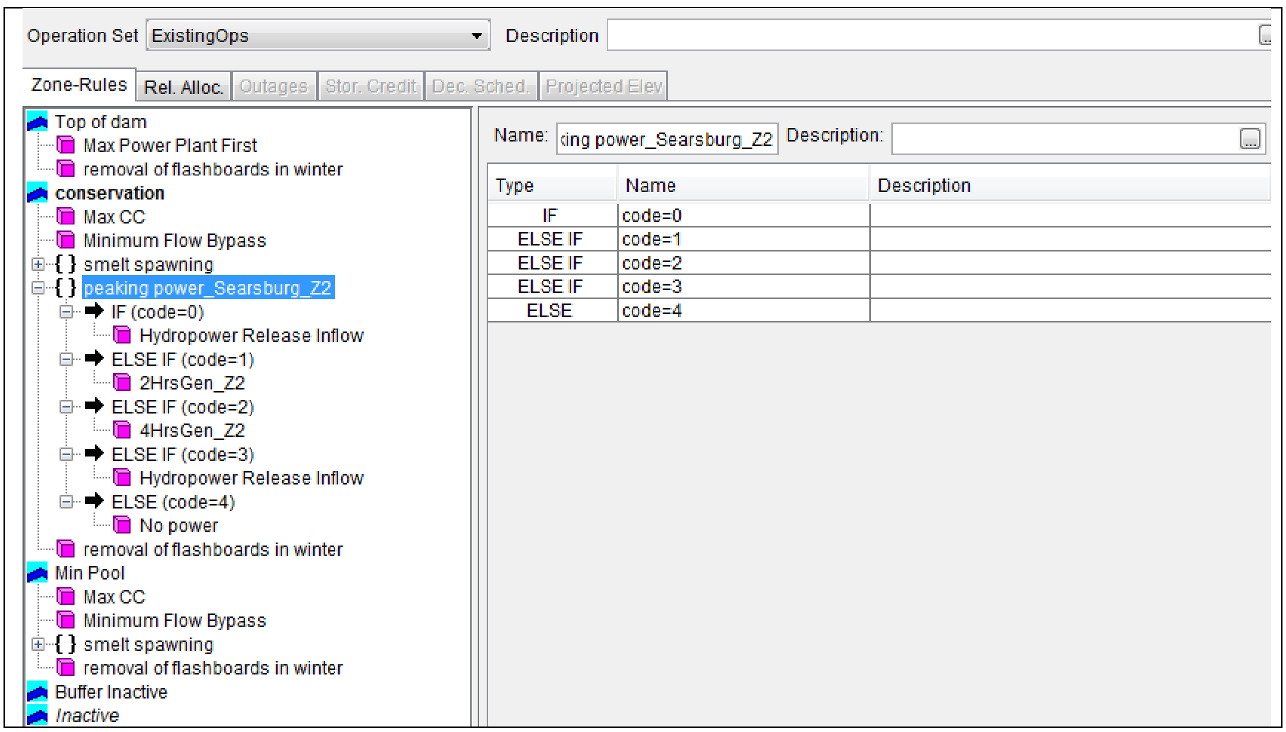
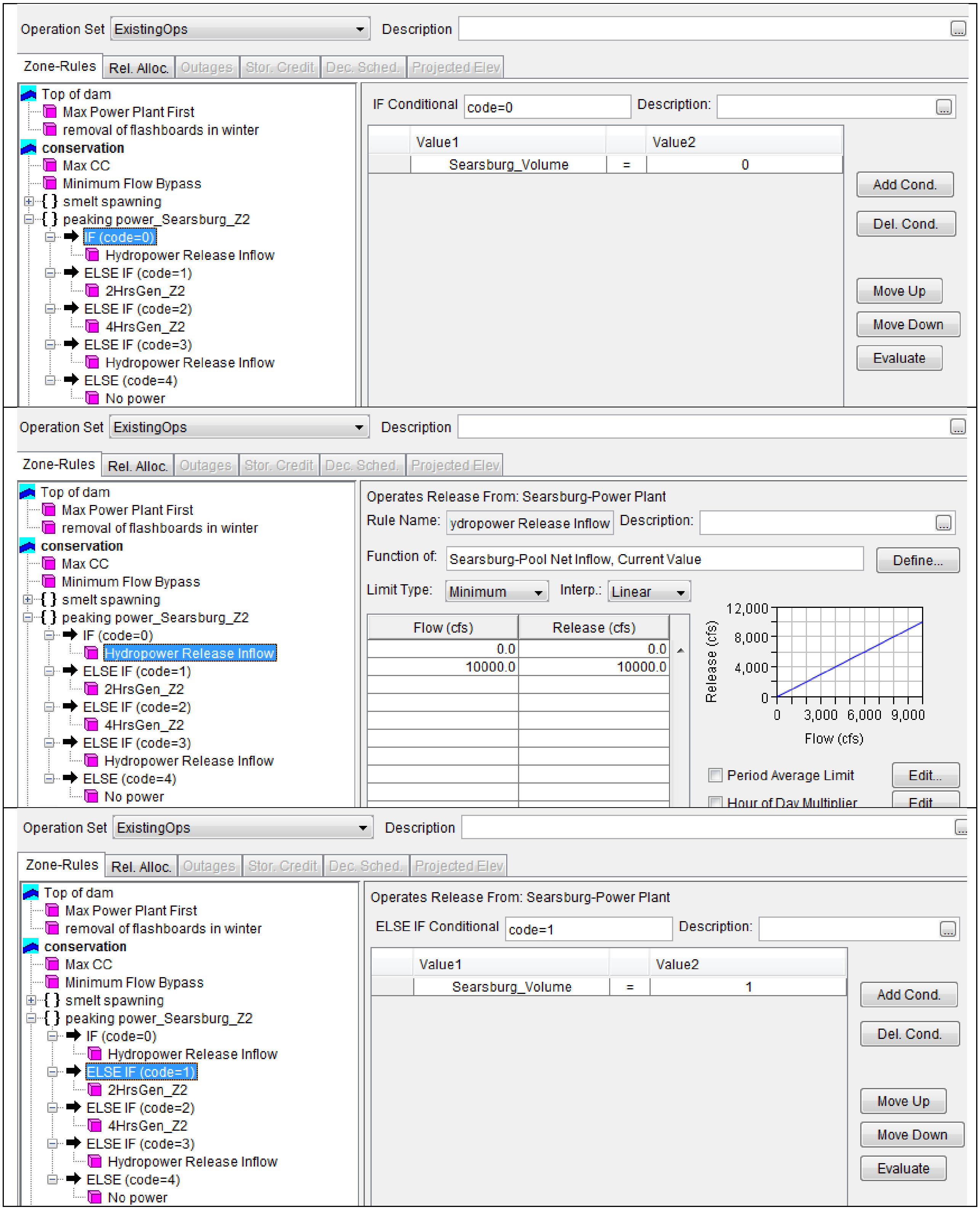


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Smelt Spawning

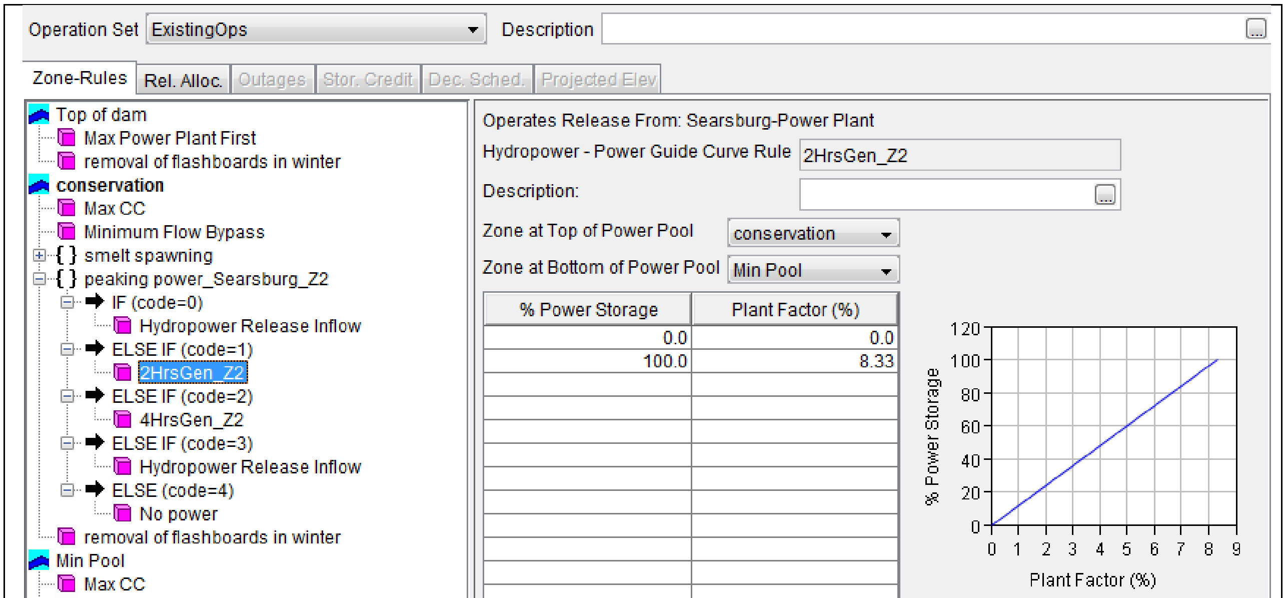
6. *Peaking power_Searsburg_Z2*

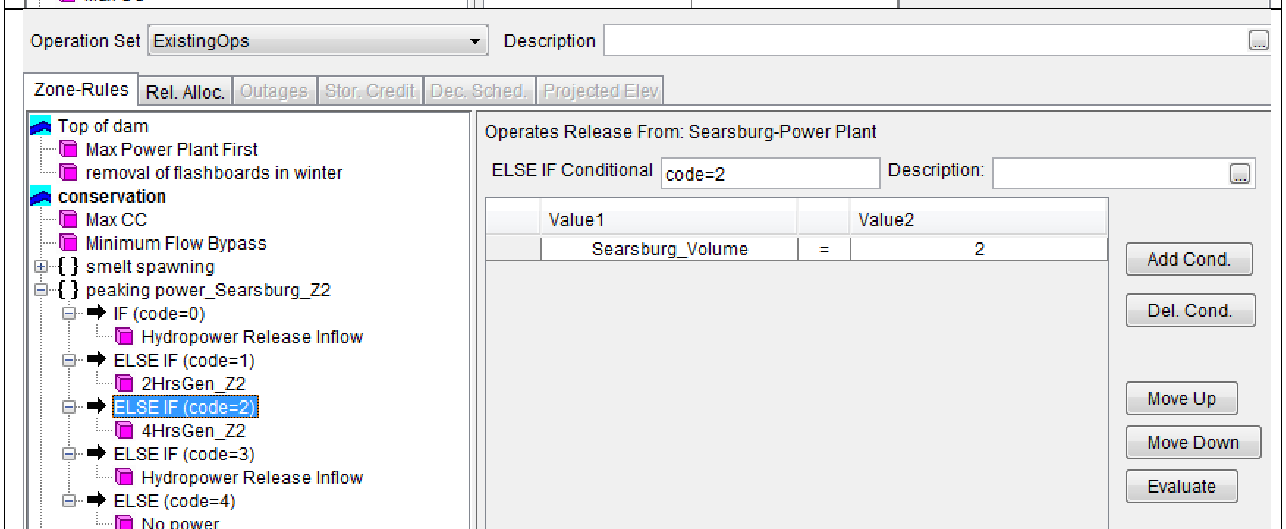
This rule represents power strategy applied for Searsburg reservoir. The content of the rule is shown in Figure 11 as per the peaking hydropower modeling strategy.

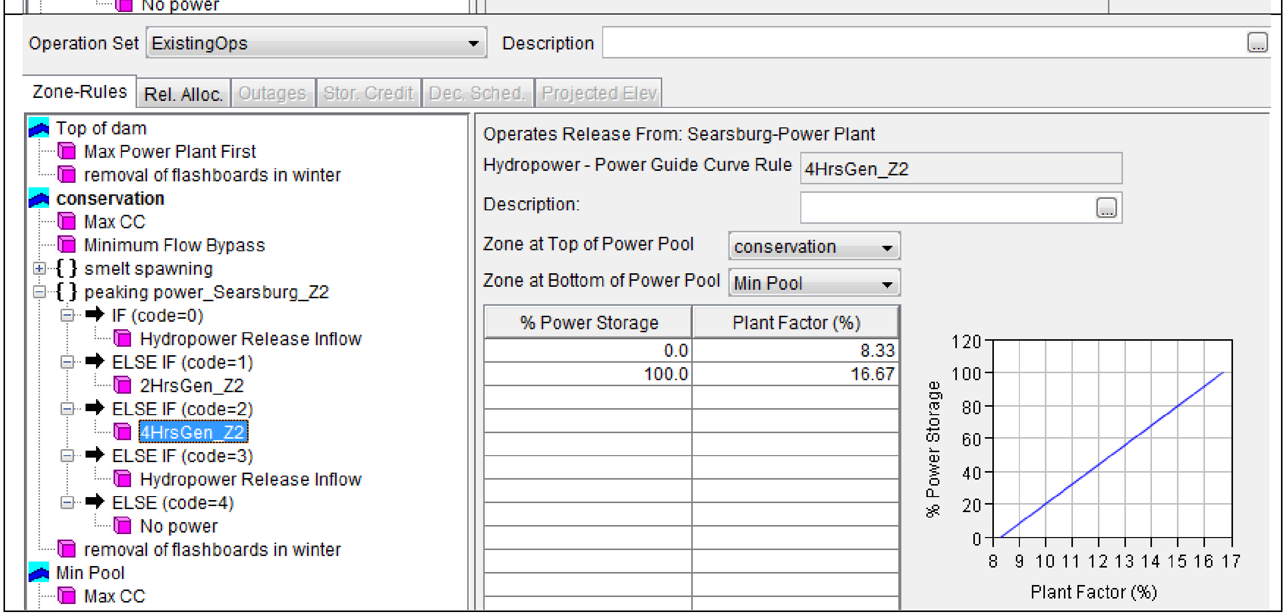


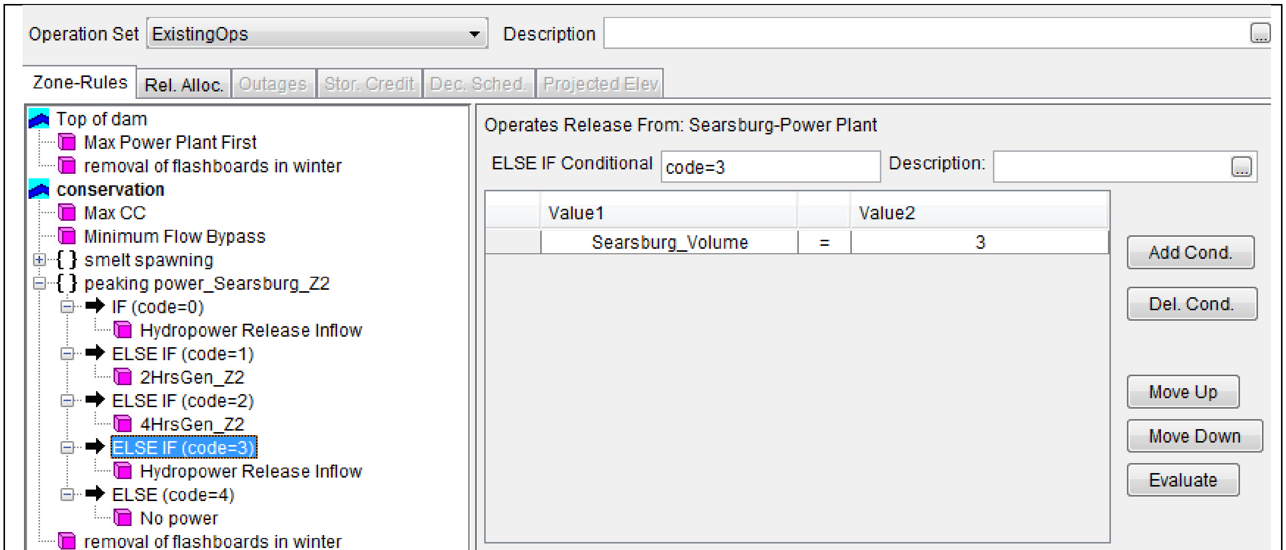


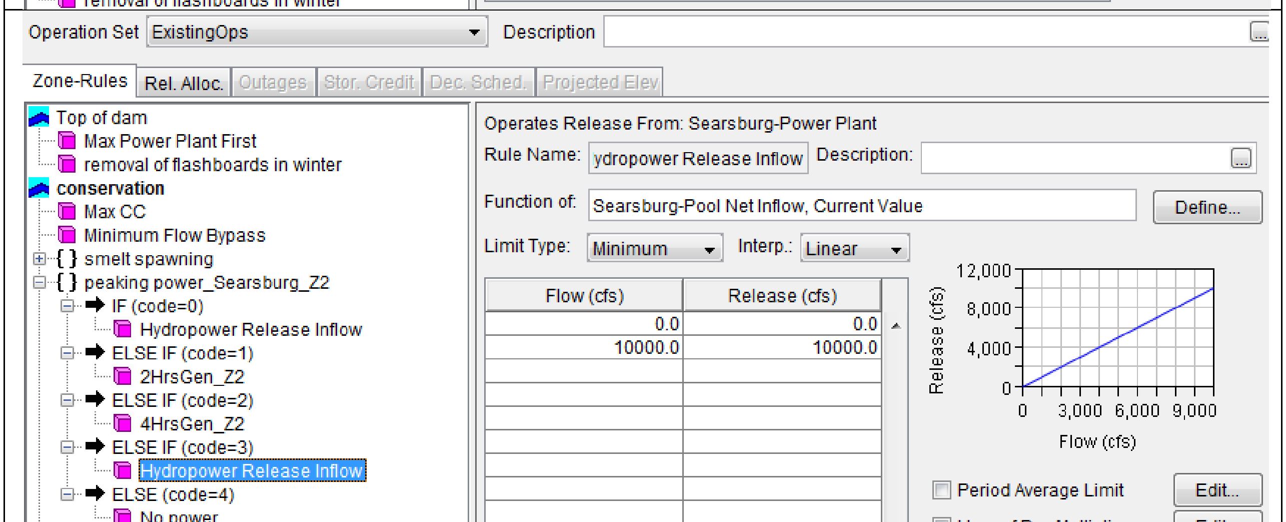
Operation Set
ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
removal of flashboards in winter
conservation
Max CC
Minimum Flow Bypass
{ } smelt spawning
{ } peaking power_Searsburg_Z2
IF (code=0)
Hydropower Release Inflow
ELSE IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No power
IF Conditional
code=0
Description:
Value1
Value2
Searsburg_Volume
=
0
Add Cond.
Del. Cond.
Move Up
Move Down
Evaluate
Operates Release From: Searsburg-Power Plant
Rule Name:
ydropower Release Inflow
Function of:
Searsburg-Pool Net Inflow, Current Value
Define...
Limit Type:
Minimum
Interp.:
Linear
Flow (cfs)
Release (cfs)
0.0
0.0
10000.0
10000.0
12,000
8,000
4,000
0
Release (cfs)
0
3,000
6,000
9,000
Flow (cfs)
Period Average Limit
Edit...
Hour of Day Multiplier
Edit
ELSE IF Conditional
code=1
Searsburg_Volume
=
1

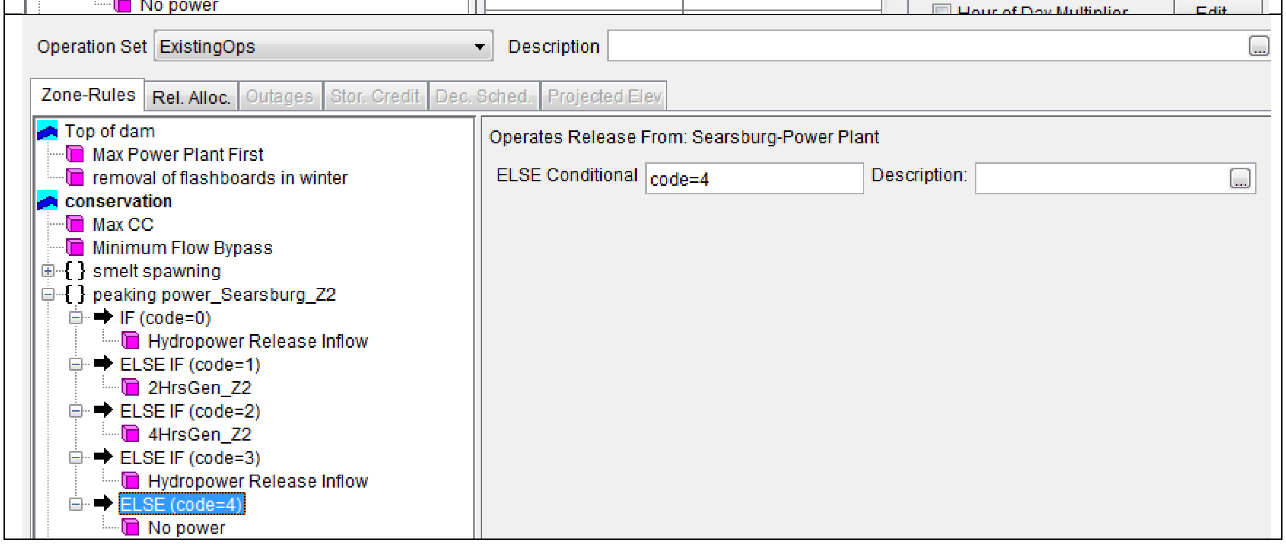

Operation Set
ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
removal of flashboards in winter
conservation
Max CC
Minimum Flow Bypass
smelt spawning
peaking power_Searsburg_Z2
IF (code=0)
Hydropower Release Inflow
ELSE IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No power
removal of flashboards in winter
Min Pool
Max CC
Operates Release From: Searsburg-Power Plant
Hydropower - Power Guide Curve Rule
2HrsGen_Z2
Description:
Zone at Top of Power Pool
conservation
Zone at Bottom of Power Pool
Min Pool
% Power Storage
Plant Factor (%)
0.0
0.0
100.0
8.33
% Power Storage
Plant Factor (%)


Operation Set
ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
removal of flashboards in winter
conservation
Max CC
Minimum Flow Bypass
smelt spawning
peaking power_Searsburg_Z2
IF (code=0)
Hydropower Release Inflow
ELSE IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No power
Operates Release From: Searsburg-Power Plant
ELSE IF Conditional
code=2
Description:
Value1
Value2
Searsburg_Volume
=
2
Add Cond.
Del. Cond.
Move Up
Move Down
Evaluate


Operation Set
ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
removal of flashboards in winter
conservation
Max CC
Minimum Flow Bypass
smelt spawning
peaking power_Searsburg_Z2
IF (code=0)
Hydropower Release Inflow
ELSE IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No power
removal of flashboards in winter
Min Pool
Max CC
Operates Release From: Searsburg-Power Plant
Hydropower - Power Guide Curve Rule
4HrsGen_Z2
Description:
Zone at Top of Power Pool
conservation
Zone at Bottom of Power Pool
Min Pool
% Power Storage
Plant Factor (%)
0.0
8.33
100.0
16.67
% Power Storage
Plant Factor (%)


Operation Set ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
removal of flashboards in winter
conservation
Max CC
Minimum Flow Bypass
smelt spawning
peaking power_Searsburg_Z2
IF (code=0)
Hydropower Release Inflow
ELSE IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No power
removal of flashboards in winter
Operates Release From: Searsburg-Power Plant
ELSE IF Conditional code=3
Description:
Value1
Value2
Searsburg_Volume
=
3
Add Cond.
Del. Cond.
Move Up
Move Down
Evaluate


Operation Set ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
removal of flashboards in winter
conservation
Max CC
Minimum Flow Bypass
smelt spawning
peaking power_Searsburg_Z2
IF (code=0)
Hydropower Release Inflow
ELSE IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No power
Operates Release From: Searsburg-Power Plant
Rule Name: ydropower Release Inflow
Description:
Function of: Searsburg-Pool Net Inflow, Current Value
Define...
Limit Type: Minimum
Interp.: Linear
Flow (cfs)
Release (cfs)
0.0
0.0
10000.0
10000.0
12,000
8,000
4,000
0
Release (cfs)
0
3,000
6,000
9,000
Flow (cfs)
Period Average Limit
Edit...


Operation Set ExistingOps
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
removal of flashboards in winter
conservation
Max CC
Minimum Flow Bypass
smelt spawning
peaking power_Searsburg_Z2
IF (code=0)
Hydropower Release Inflow
ELSE IF (code=1)
2HrsGen_Z2
ELSE IF (code=2)
4HrsGen_Z2
ELSE IF (code=3)
Hydropower Release Inflow
ELSE (code=4)
No power
Operates Release From: Searsburg-Power Plant
ELSE Conditional code=4
Description:

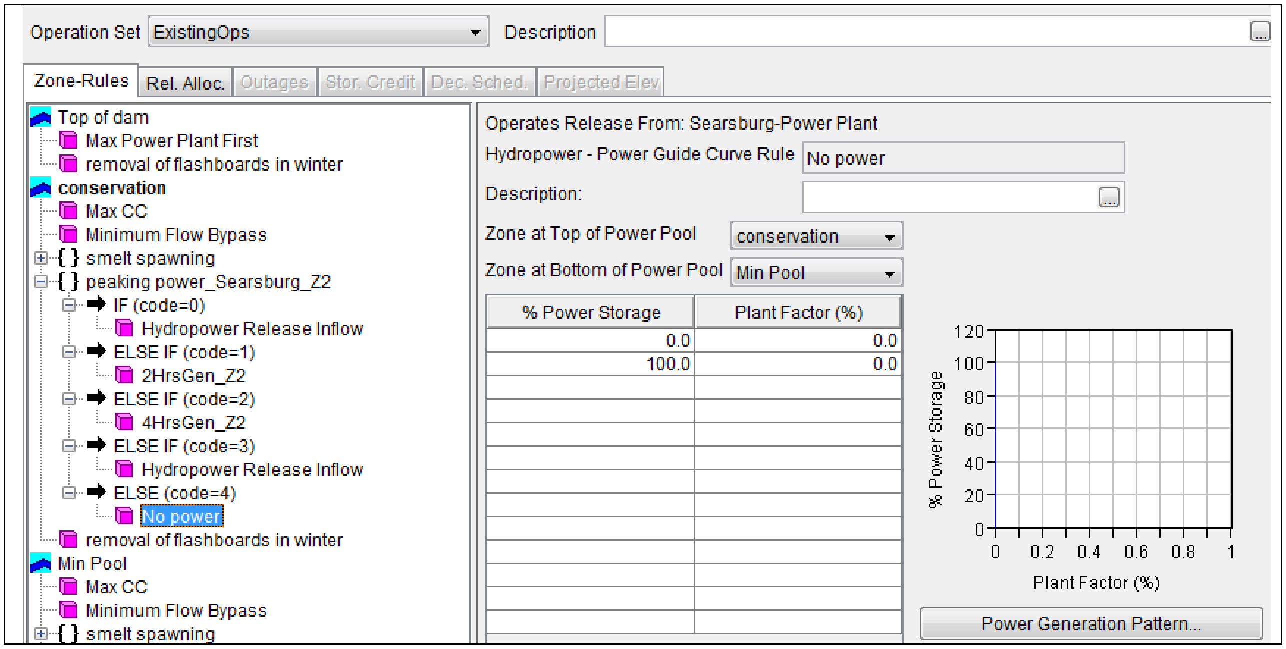


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Hydropower_Searsburg_Z2

Figure 14 describes the definition of codes used in the Searsburg_Volume state variable. The code is summing up the current Inflow and previous storage in each time step, compare it to the volume needed for generating 2 and 4 hours power and to the spillway storage minus inactive storage and then decide how much to release.

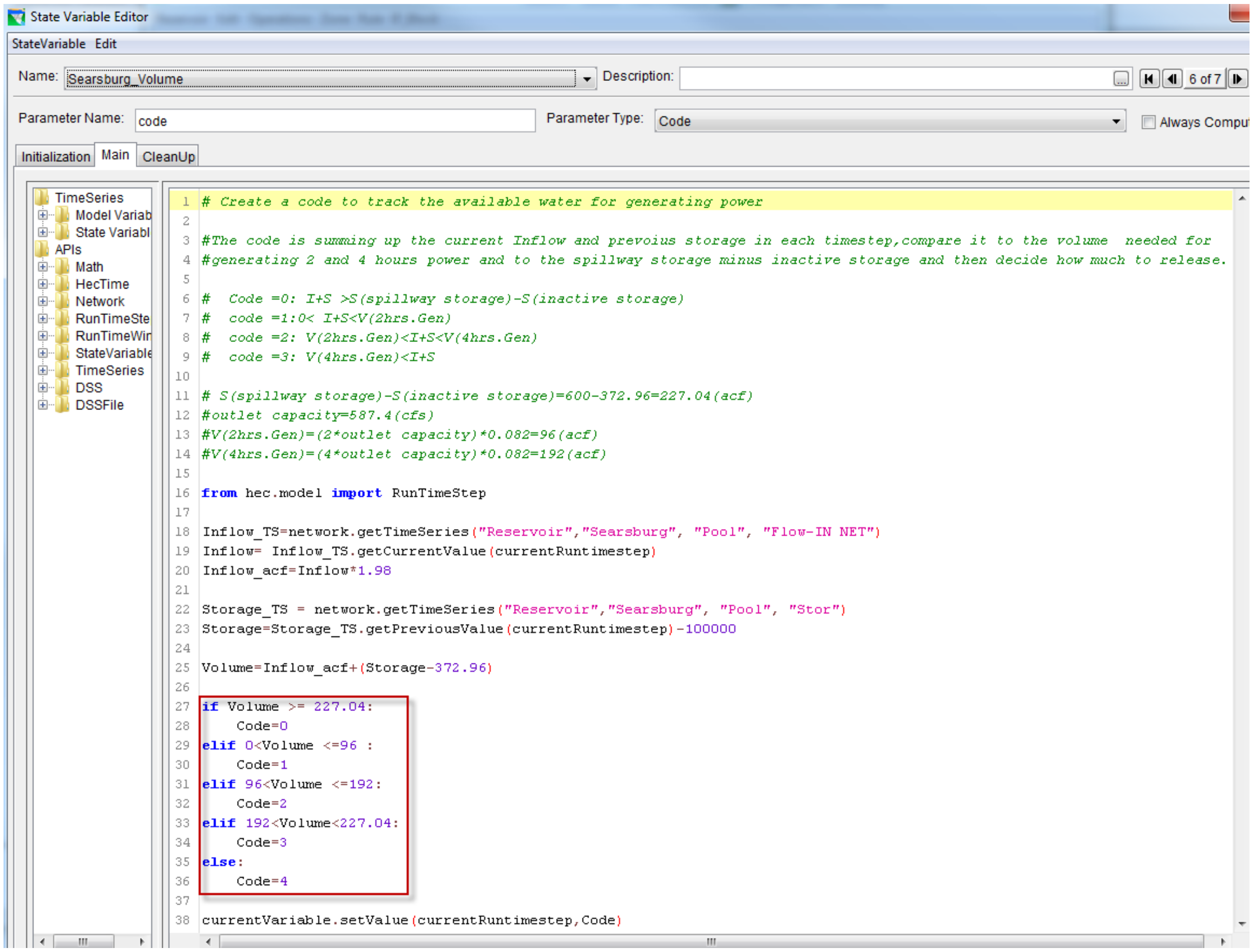


Figure 14: State Variable Editor: Searsburg_Volume

Second Connecticut Lake

I. Overview

Second Connecticut Lake dam is located 8 miles south of the Canadian border on the mainstem Connecticut River. It is owned and operated by TransCanada Hydro Northeast Inc. as a storage reservoir to make releases to its downstream hydro facilities.

Figure 1 shows the location of Second Connecticut Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from Second Connecticut Dam.

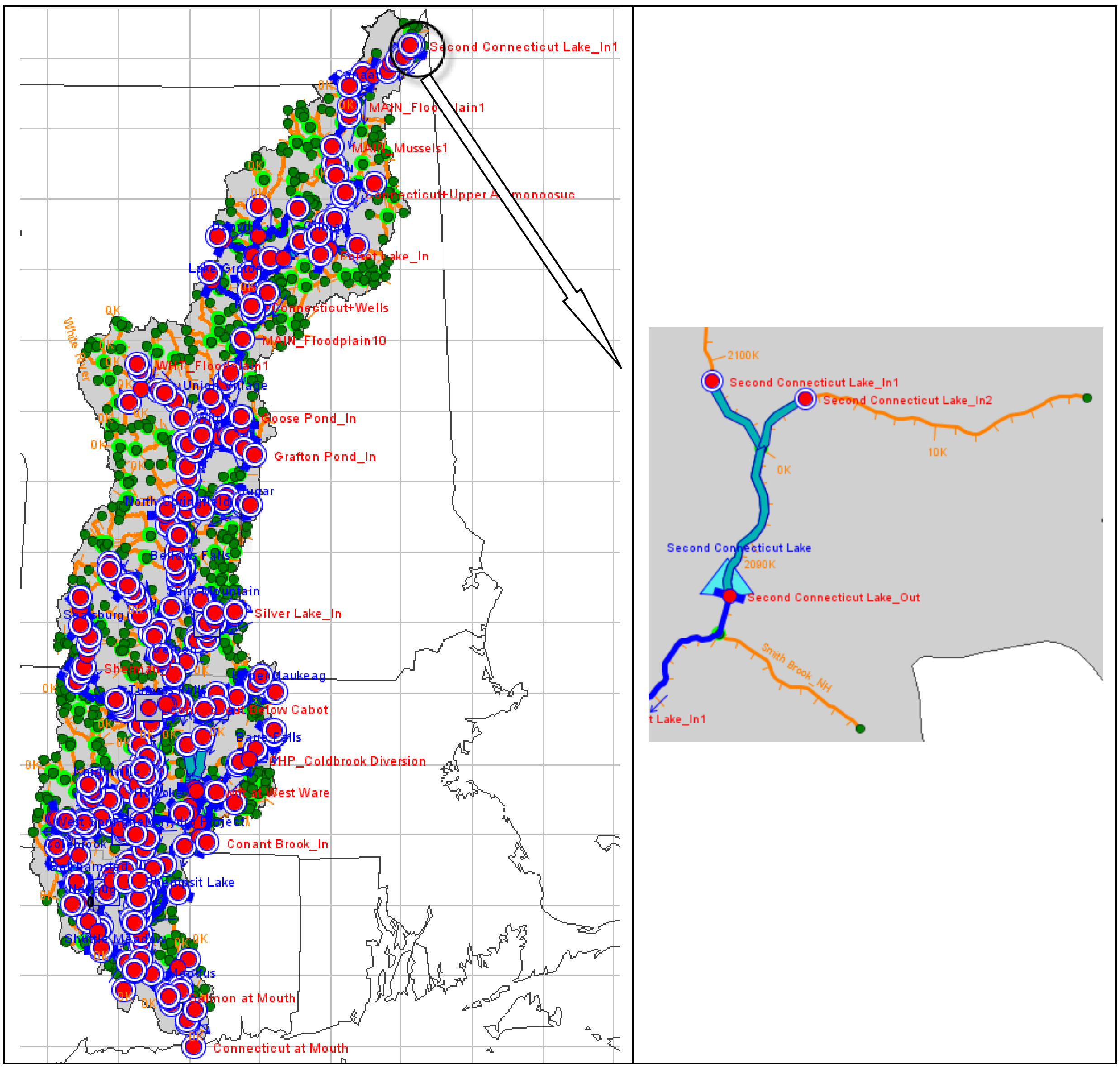


Figure 1: HEC-ResSim Map Display Showing Location of Second Connecticut Dam

Figure 2: Photo of Second Connecticut Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[84]. The dam consists of four types of outlets: (1) controlled Log way, (2) uncontrolled spillway, (3) controlled Fish Pipe, and (4) controlled Waste way as shown in Figure 4.

[84] Data provided by TransCanada

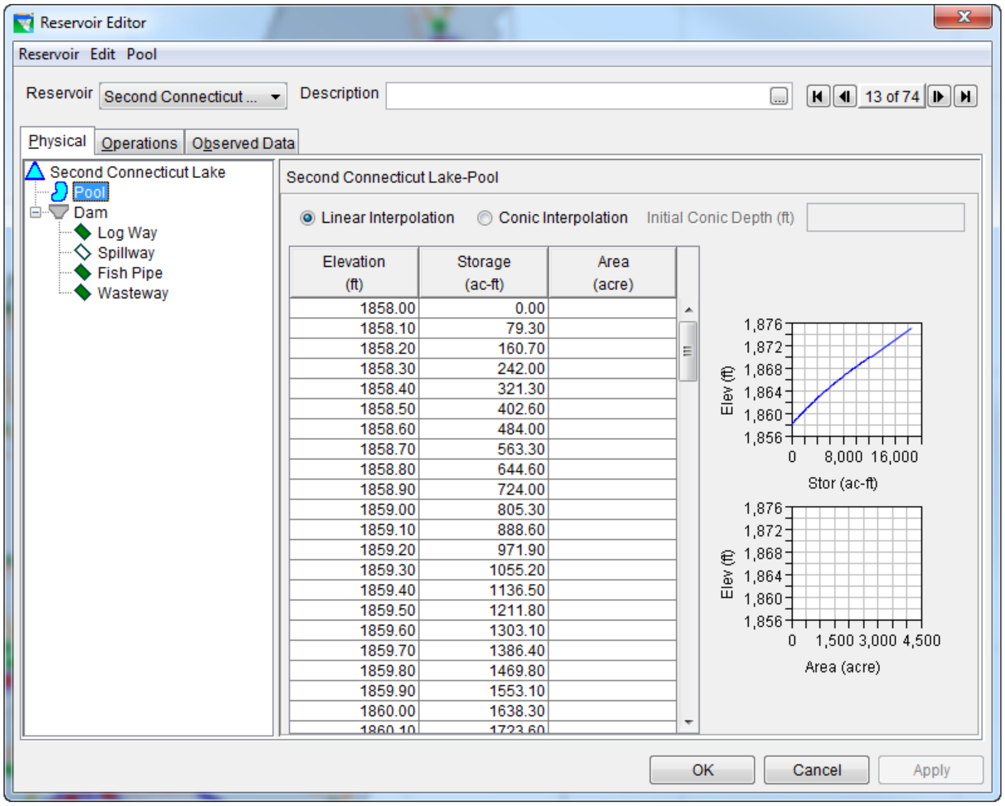


Figure 3: Reservoir Editor: Physical Tab -- Pool

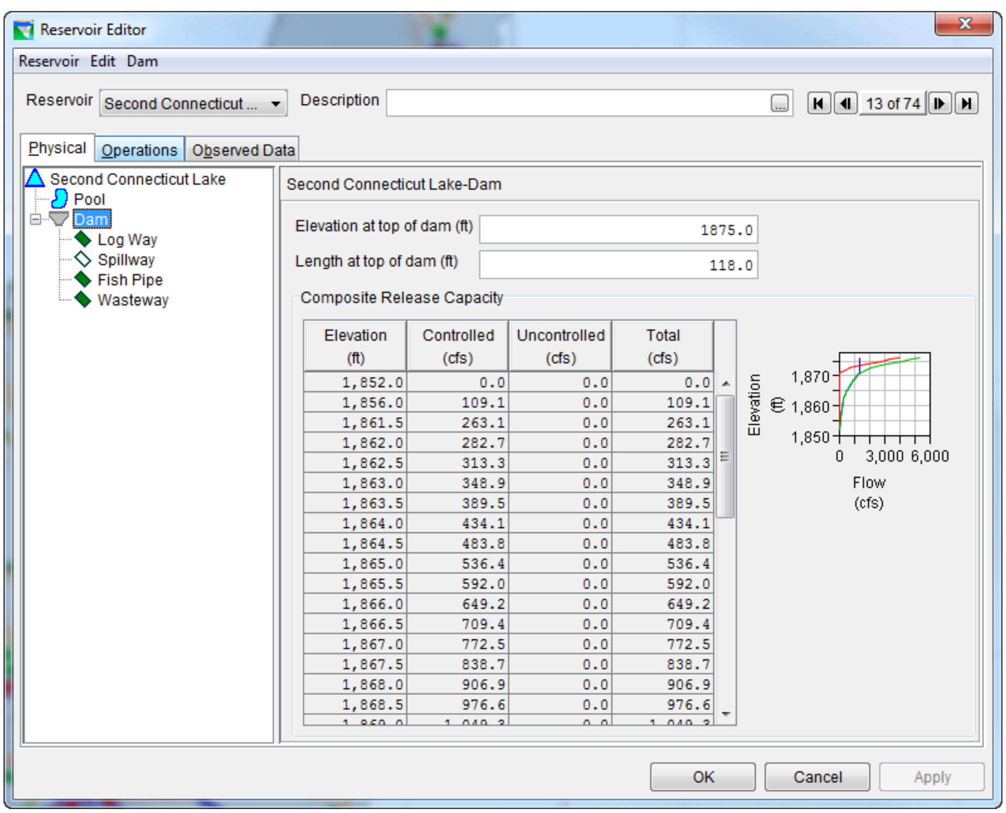


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Second Connecticut Dam's "Existing Ops" operational zones, which consist of zones of Top of dam (1875 ft), Below Top of dam (1874 ft), Conservation (1861.248-1867.215 ft), Operational Inactive (1860 ft), and Inactive zone (1859 ft). The Conservation Pool Elevation curve was created from 10 years of weekly average pool elevation[1].

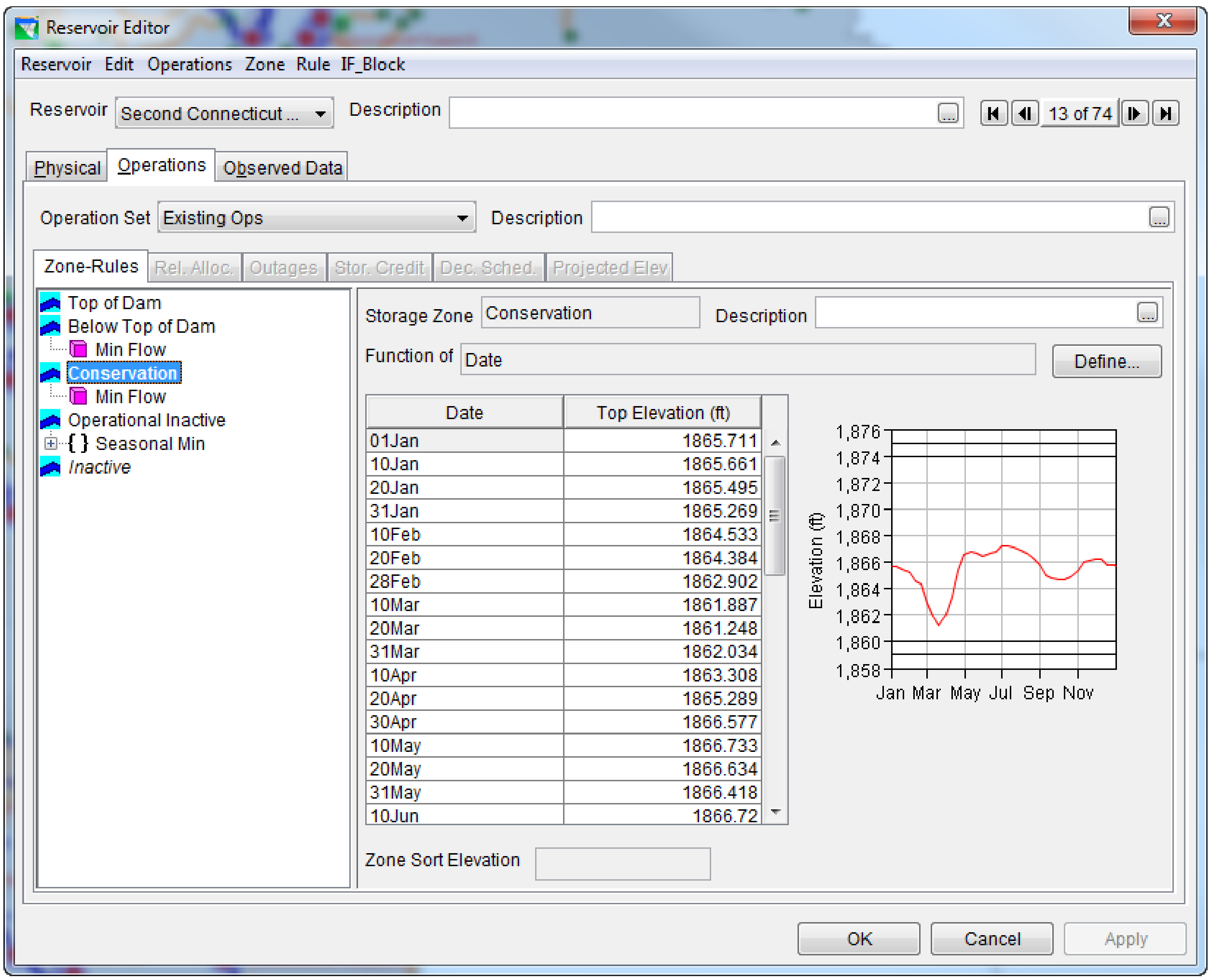


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[85].

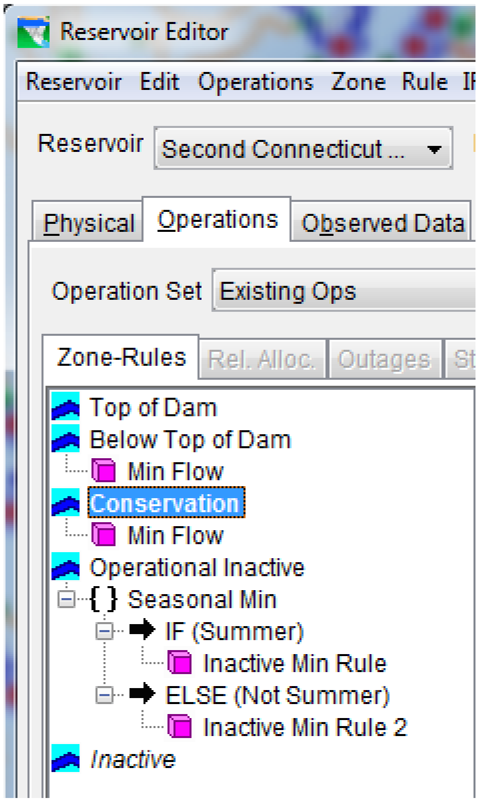


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[85] TransCanada. Connecticut River Operational Constraints. 2012.

C. Rule Descriptions

1. *Min Flow*

Figure 7 shows the content of “Min Flow” rule. This rule represents the minimum release from dam as a function of date.

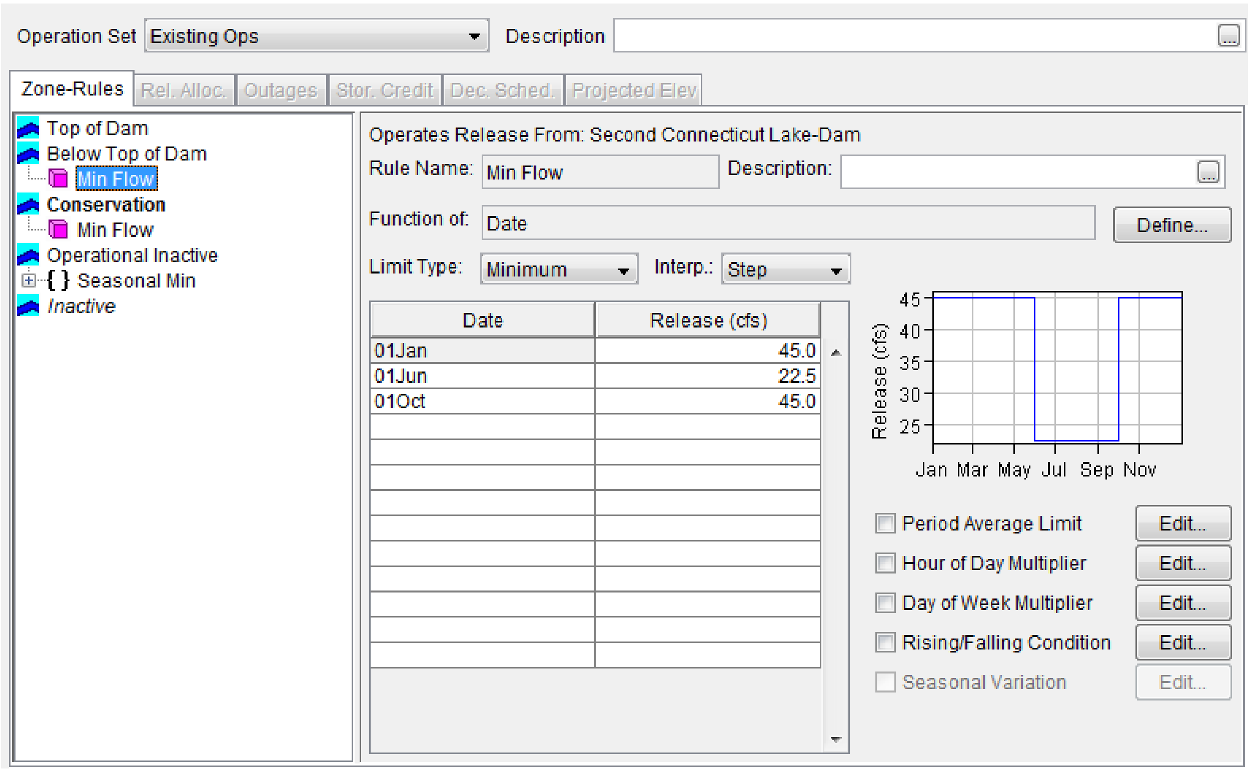
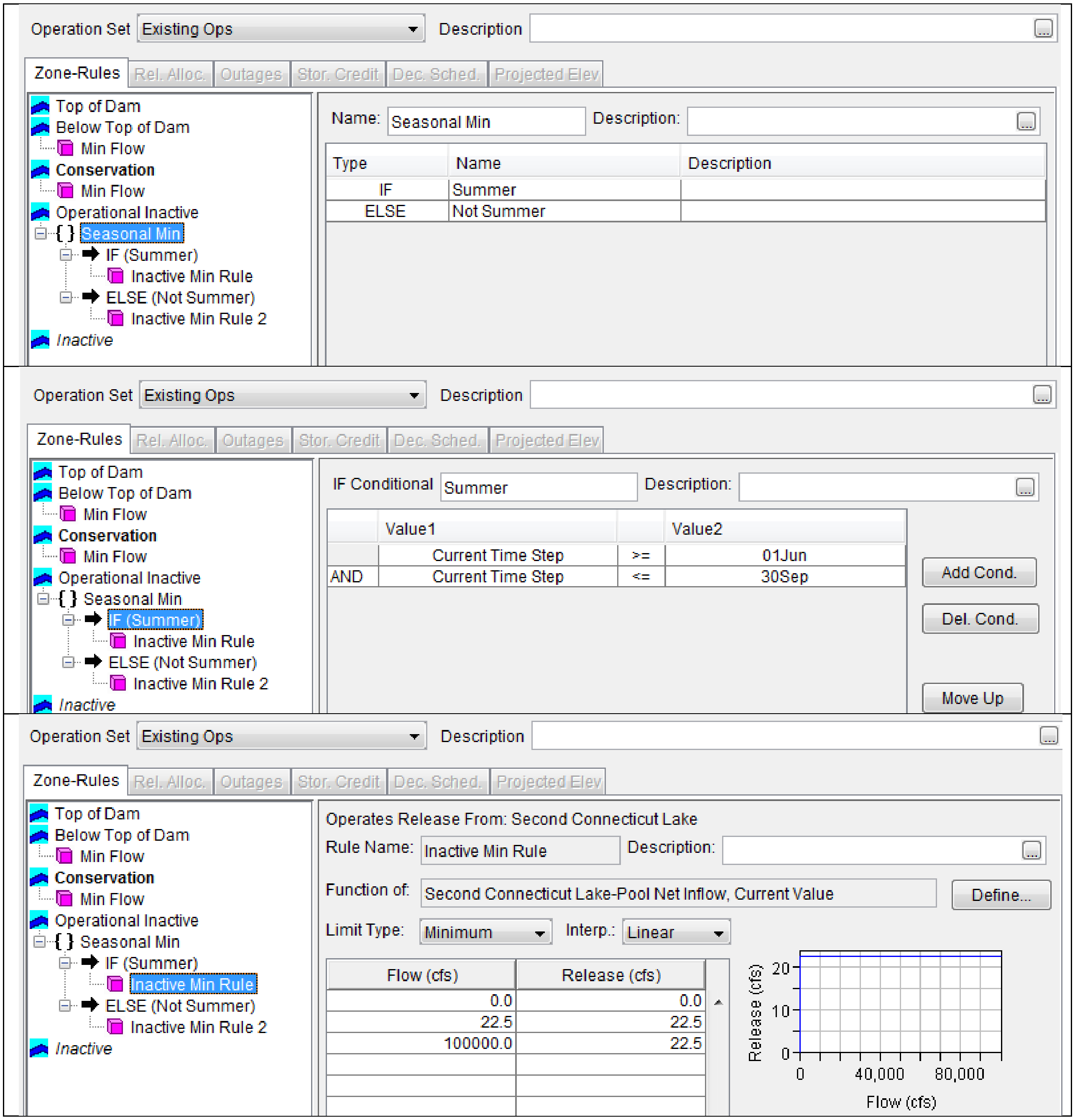


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow

2. *Seasonal Min*

Figure 8 shows the content of “Seasonal Min” rule. It represents a minimum release of 22.5 cfs for inflows greater than 22.5 cfs in summer and 45 cfs for inflows greater than 45 cfs in the rest of the year.



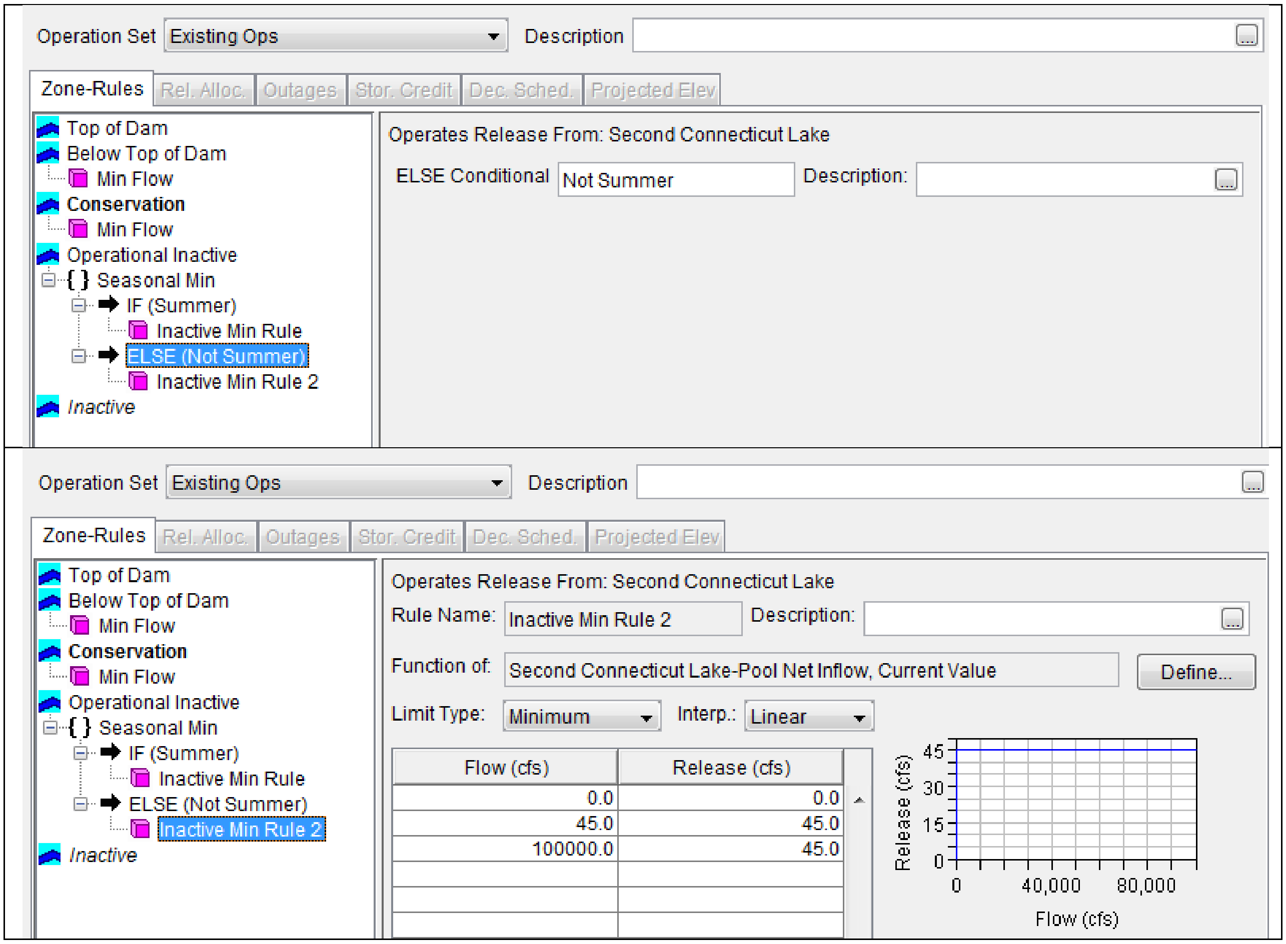


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Seasonal Min

Lake Shenipsit

I. Overview

Lake Shenipsit Dam is located in the town of Rockville, CT on the Hockanum River. It is owned and operated by the Connecticut Water Company and used as water supply for the town of Rockville.

Figure 1 shows the location of Lake Shenipsit Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Lake Shenipsit.

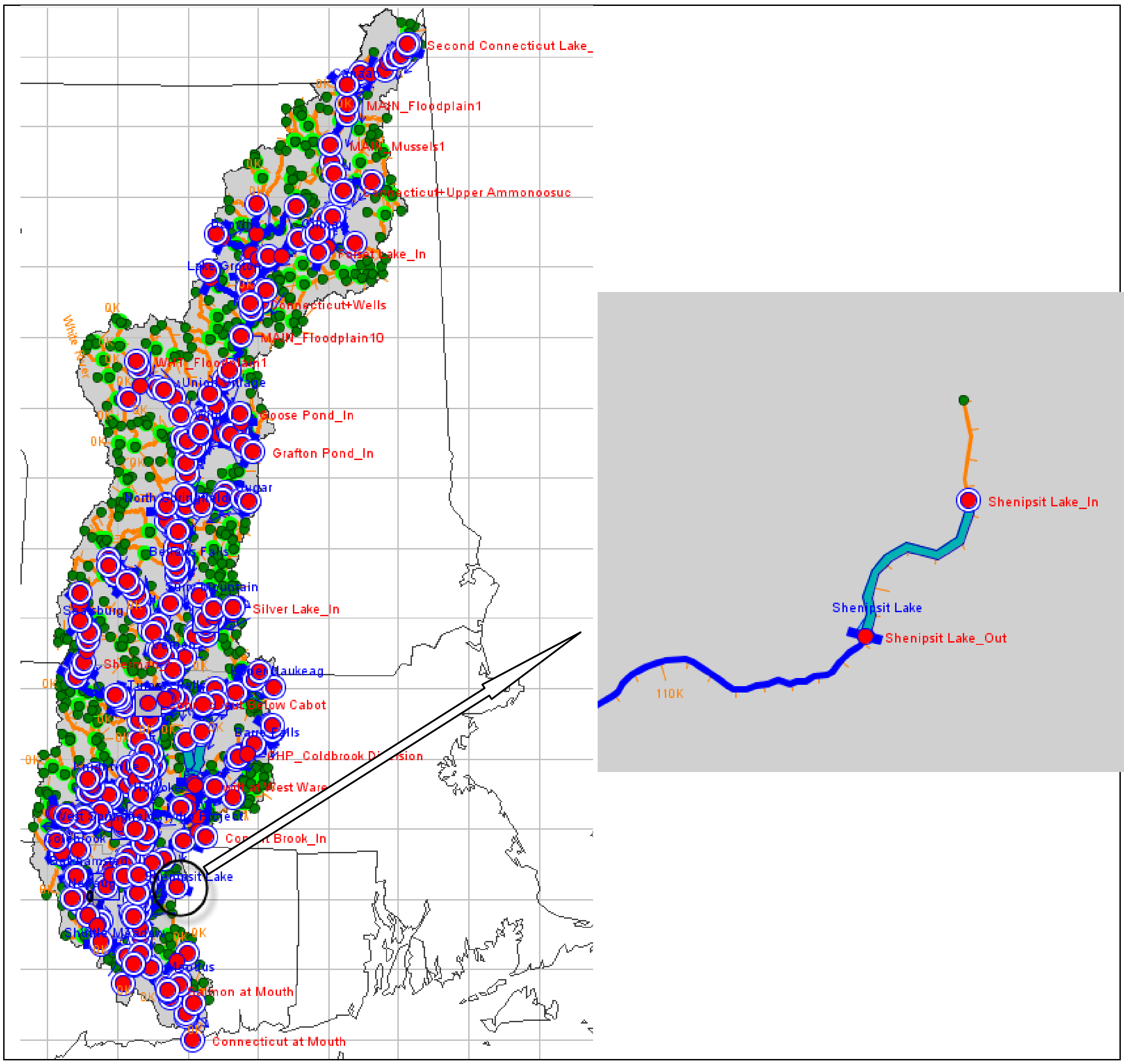


Figure 1: HEC-ResSim Map Display Showing Location of Lake Shenipsit Dam

Figure 2: Photo of Lake Shenipsit

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[86]. The dam consists of two types of outlets: (1) uncontrolled outlet, and (2) controlled water to treatment plant gate as shown in Figure 4.

[86] Data provided by Connecticut Water Company.

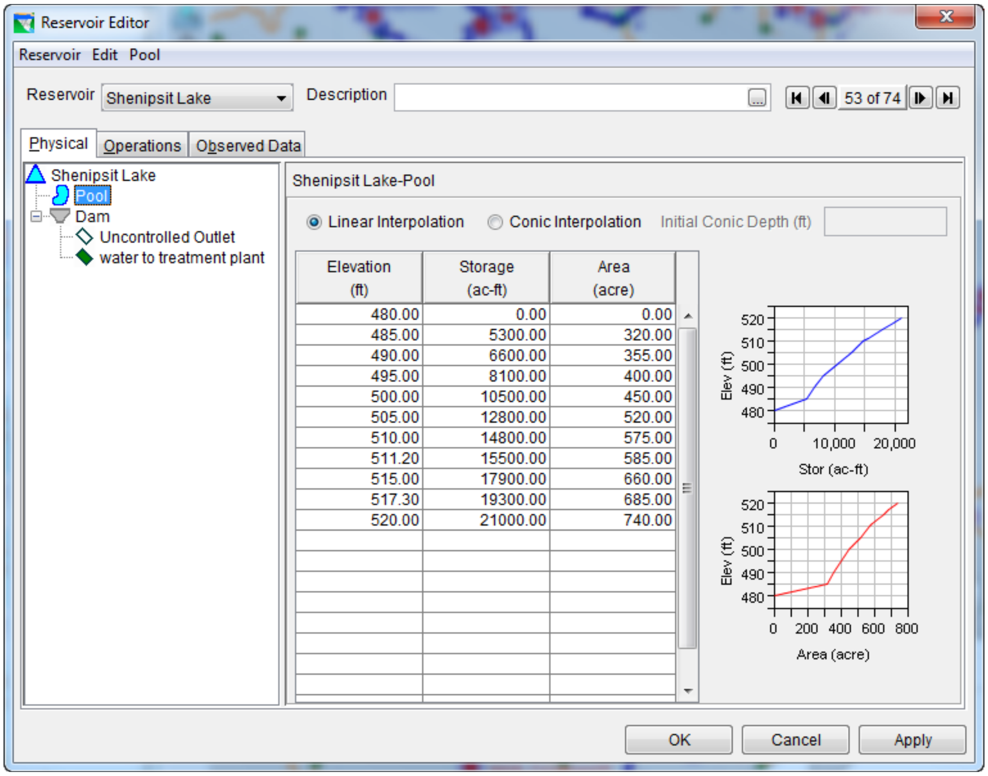


Figure 3: Reservoir Editor: Physical Tab -- Pool

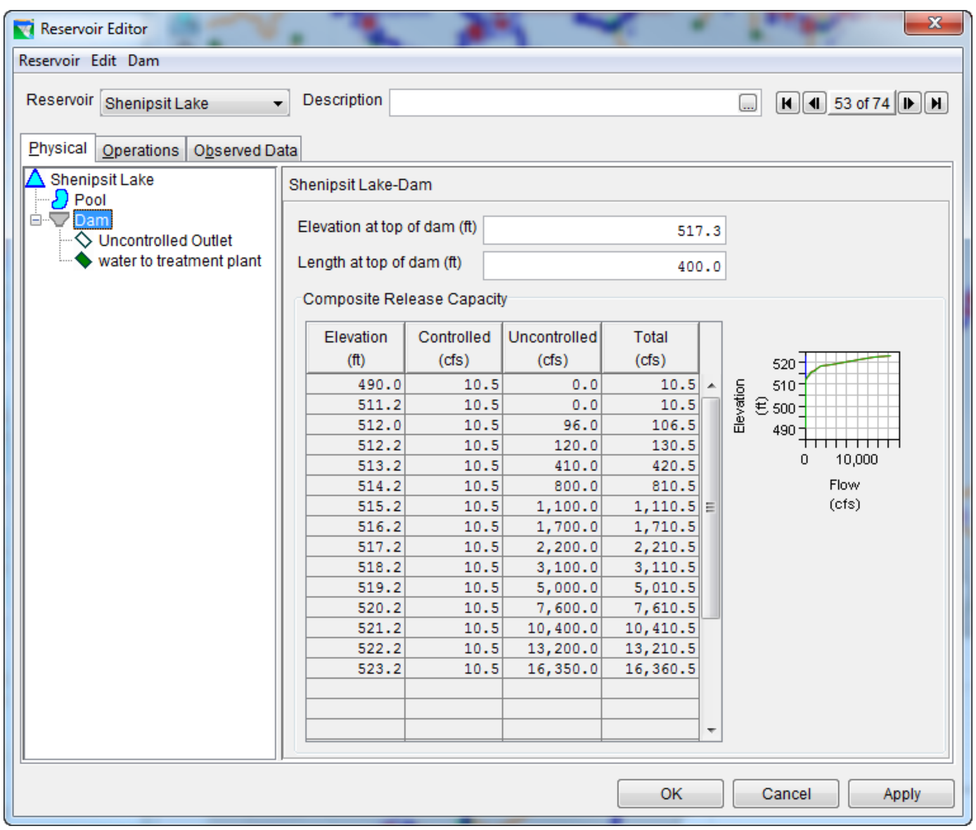


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

B. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 4 shows the definition of Shenipsit's "Existing Ops" operational zones, which consist of zones of Top of dam (517.3 ft), Flood control (512 ft), Conservation (511 ft), and Inactive zone (490 ft)[1].

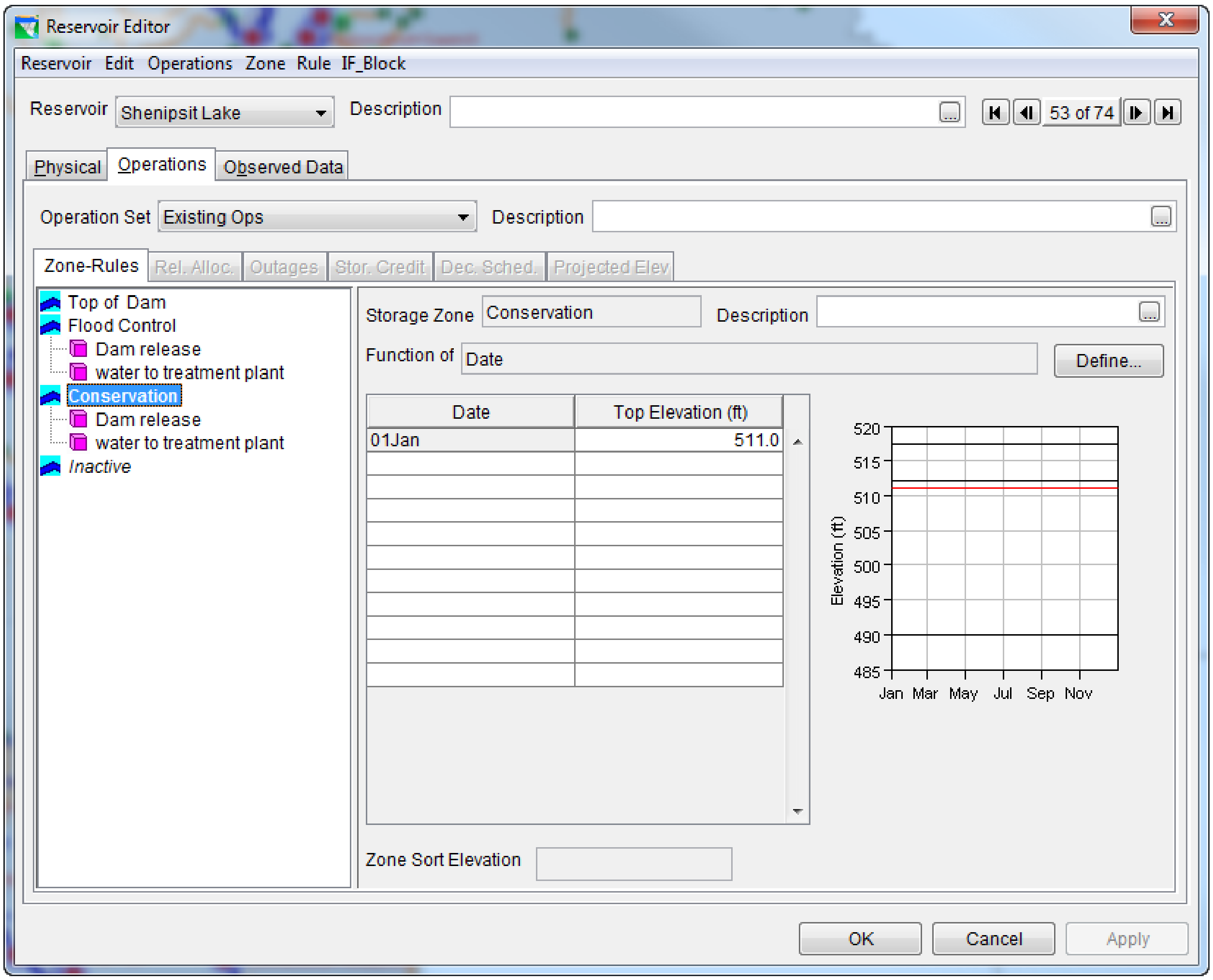


Figure 5: Reservoir Editor: Operations Tab – Existing Ops OpSet

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Guide Curve.

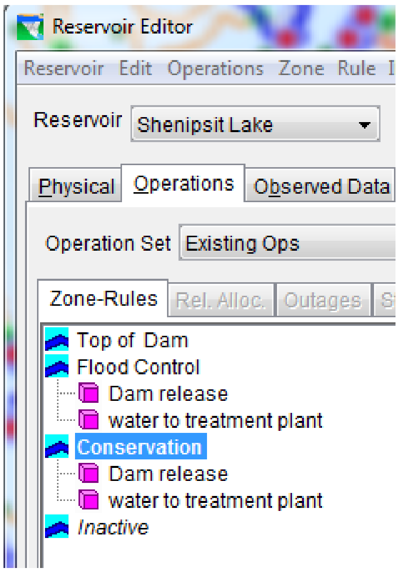


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Dam release

Figure 6 shows the content of "Dam release" rule. This rule represents the minimum release from Dam as a function of date.

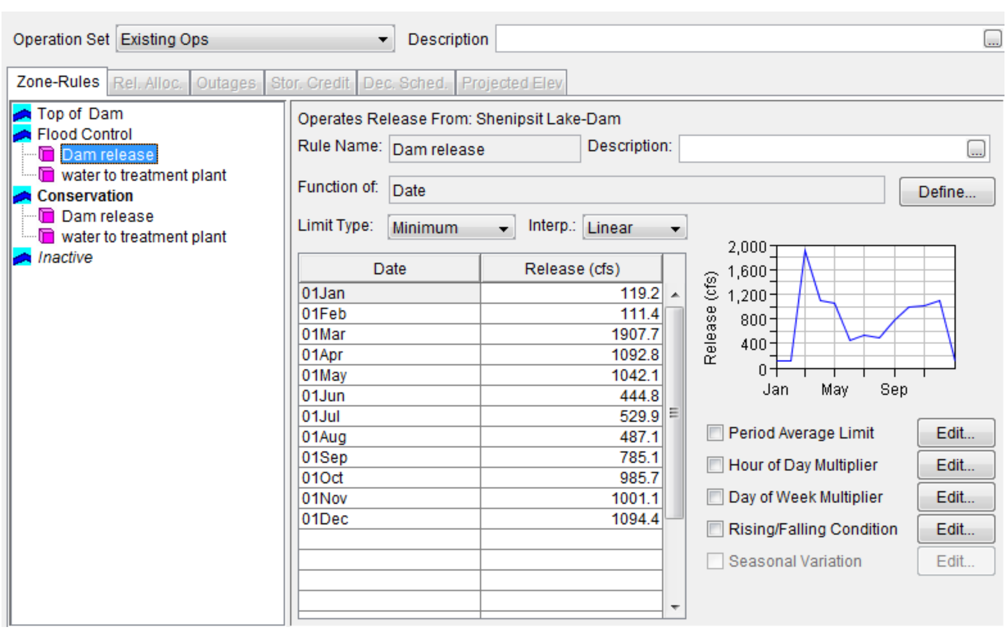


Figure 6 Reservoir Editor: Operations Tab – Existing Ops OpSet – Dam release

2. Water to treatment Plant

Figure 7 shows the content of “Water to treatment” rule. This rule represents the minimum release from “water to treatment plant” gate.

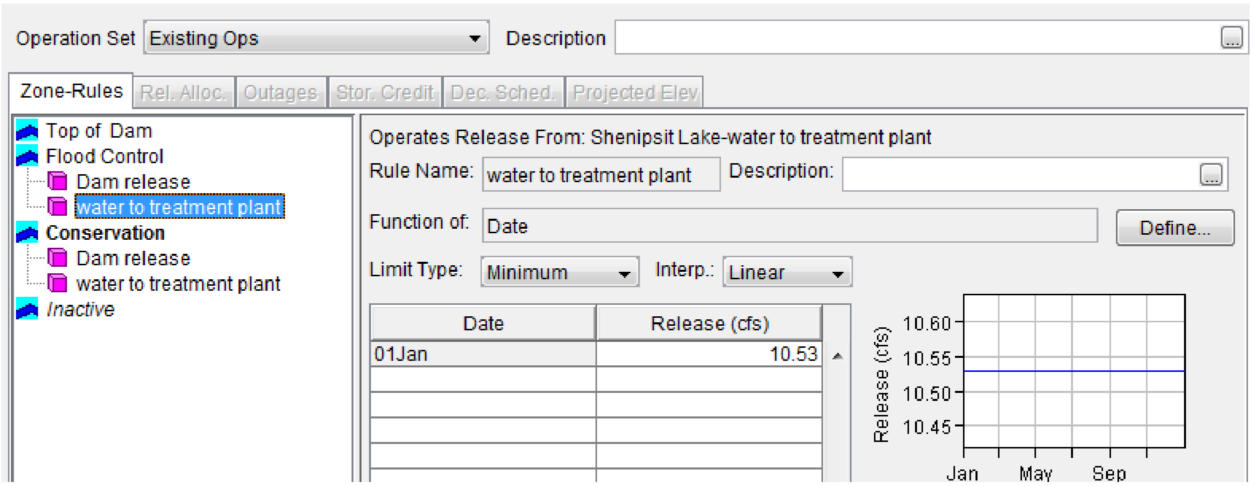


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – water to treatment plant

Sherman

I. Overview

Sherman dam is located on the Deerfield River between Readsboro and Monroe. It is owned and operated by TransCanada Hydro Northeast Inc. for hydropower generation on a peaking, weekly storage basis.

Figure 1 shows the location of Sherman dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Sherman dam.

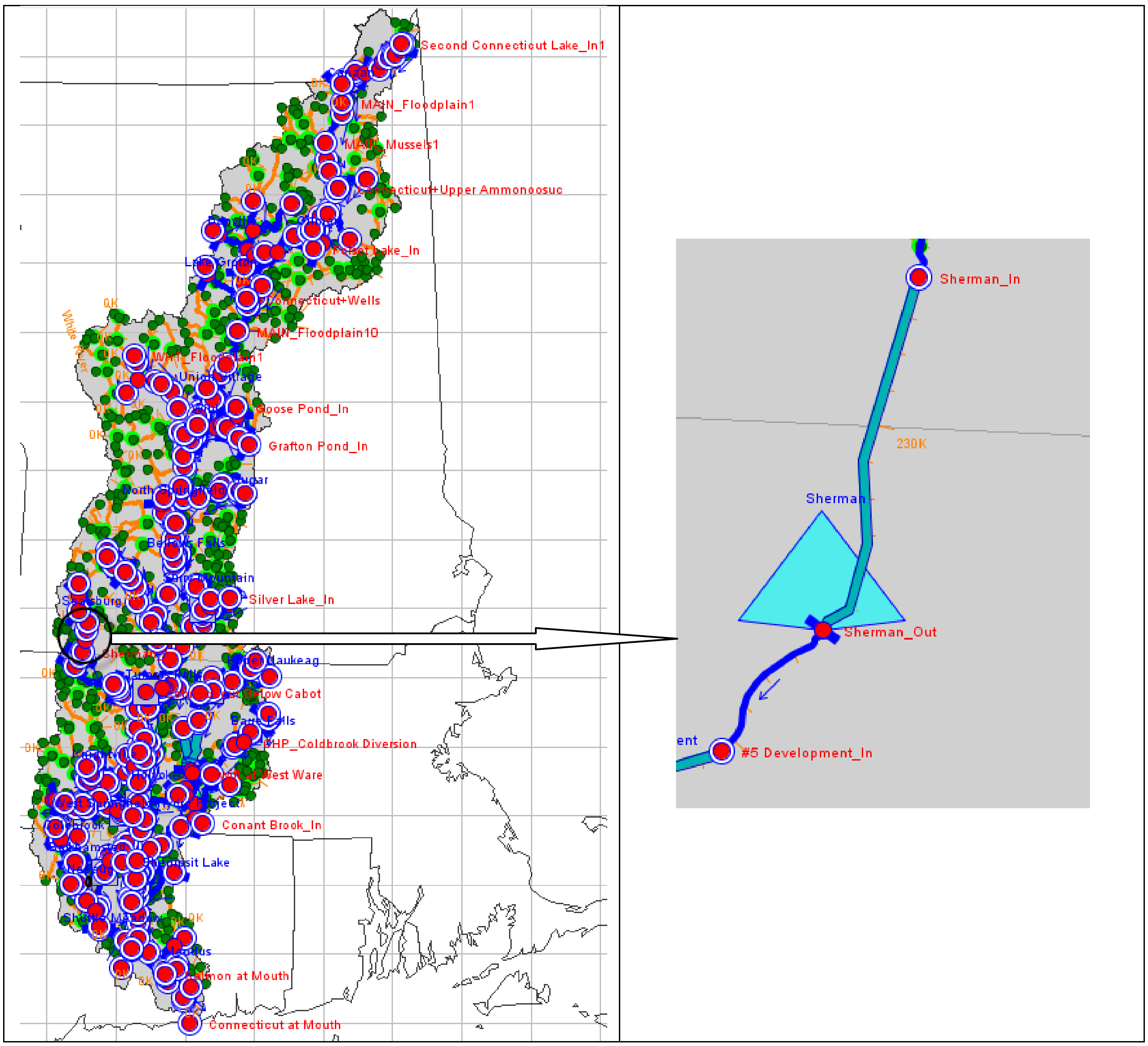


Figure 1: HEC-ResSim Map Display Showing Location of Sherman

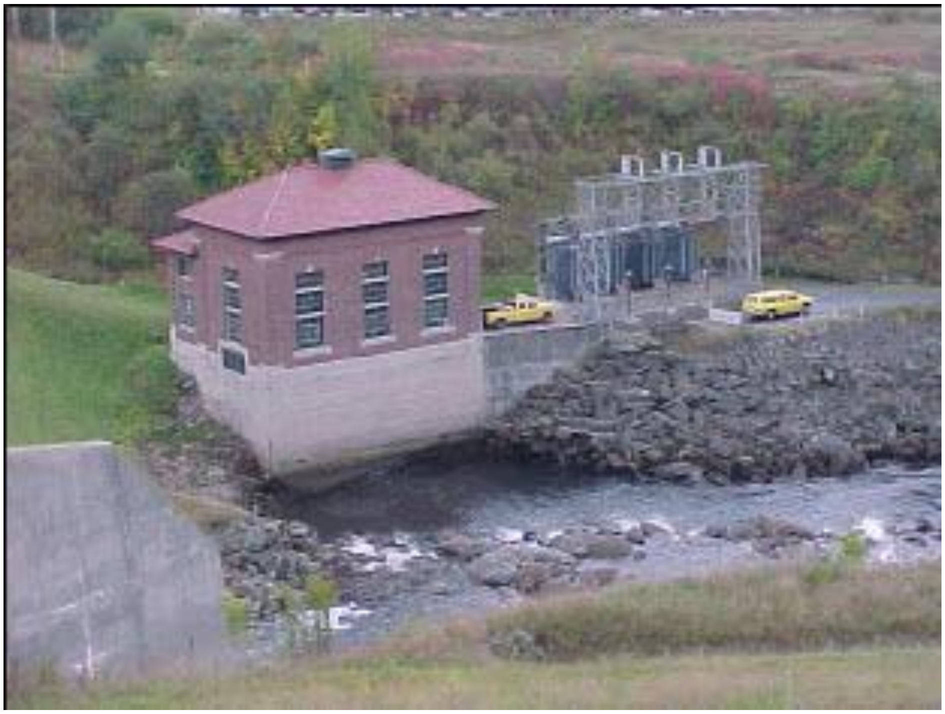


Figure 2: Photo of Sherman dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[87]. The dam consists of three types of outlets: (1) controlled spillway, (2) uncontrolled outlet, and power plant as shown in Figure 4.

.

[87] Data provided by TransCanada

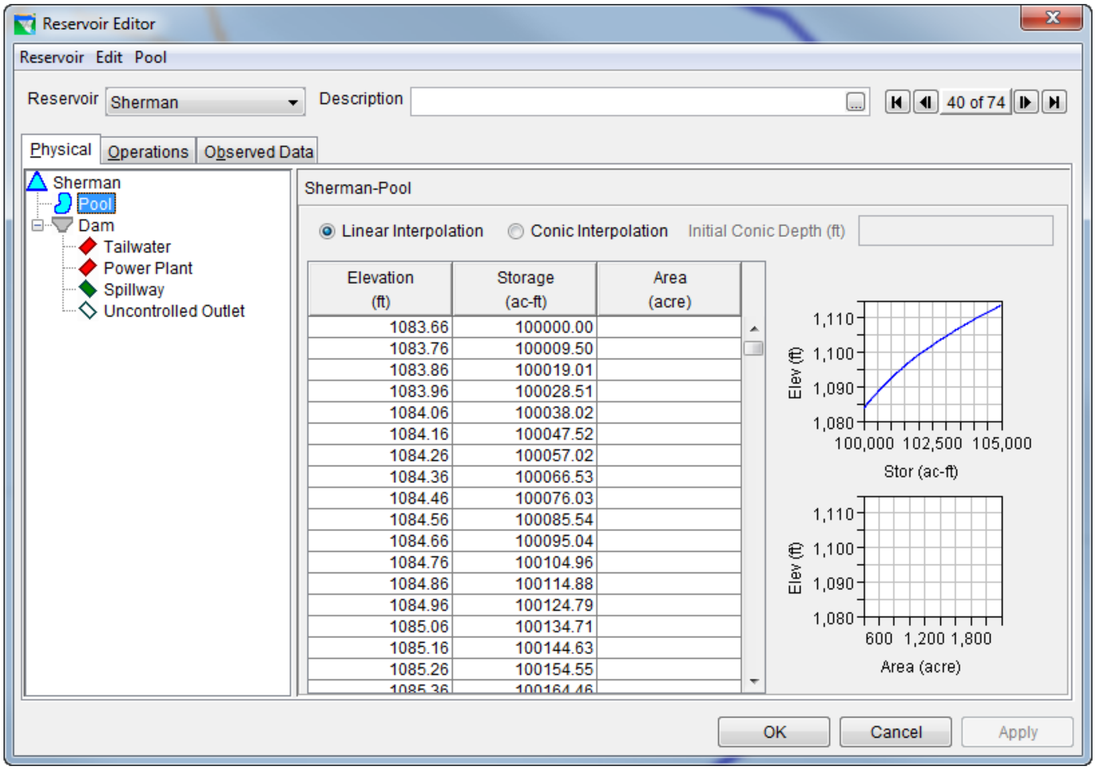


Figure 3: Reservoir Editor: Physical Tab -- Pool

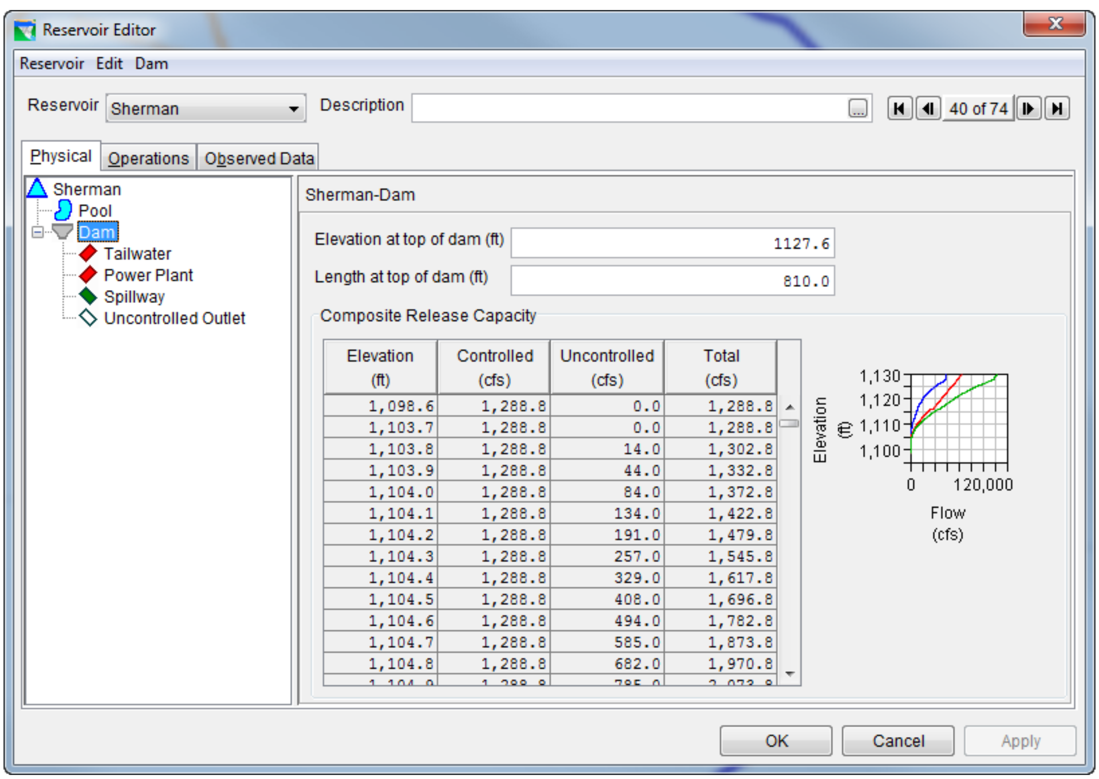


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Sherman's "Existing Ops" operational zones, which consist of zones of Top of dam (1127.6 ft), Conservation (1107.6 ft), Min Pool (1098.6 ft), and Inactive zone (997.6 ft)[1].

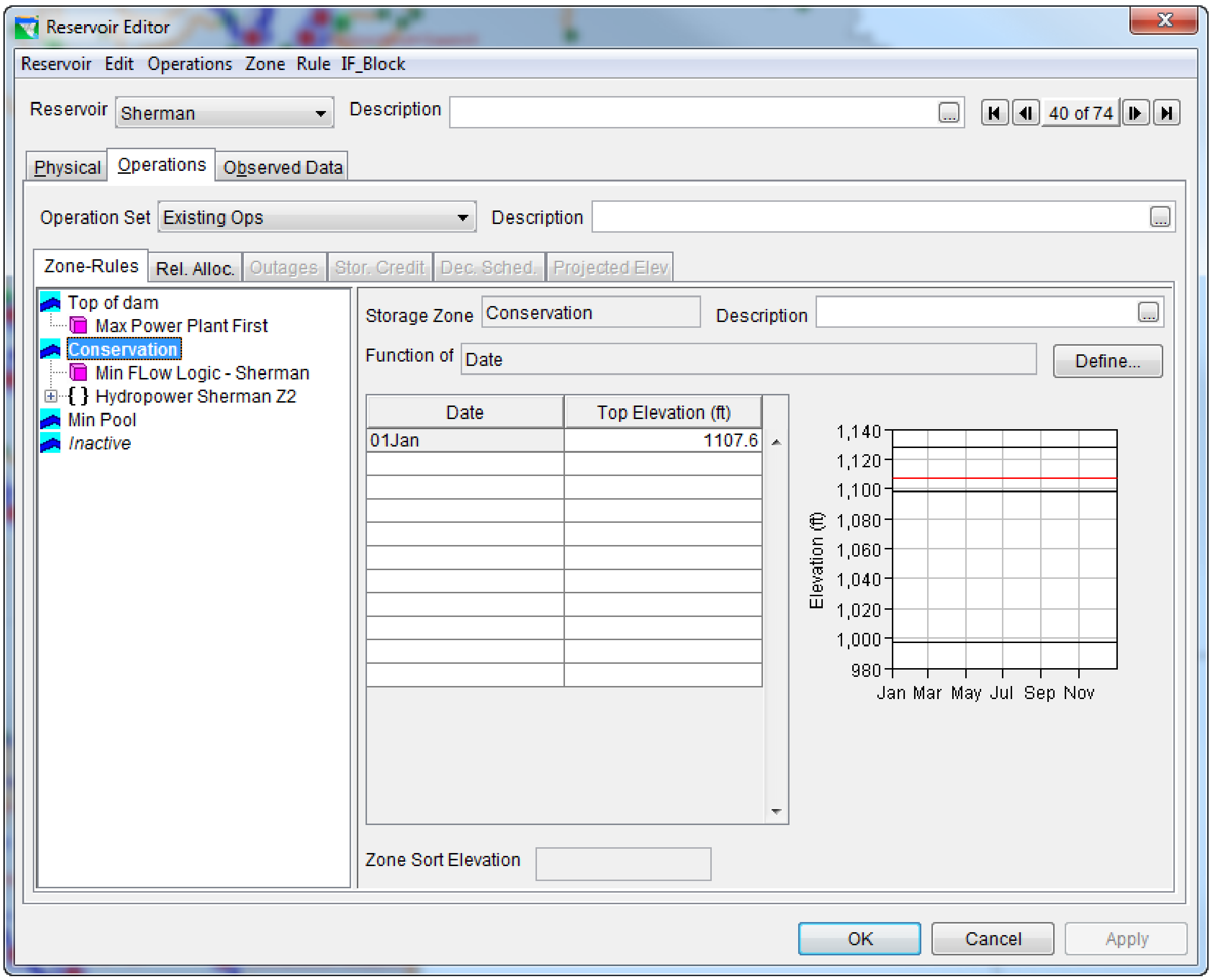


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Buford Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The spillway gets the remainder of the release.

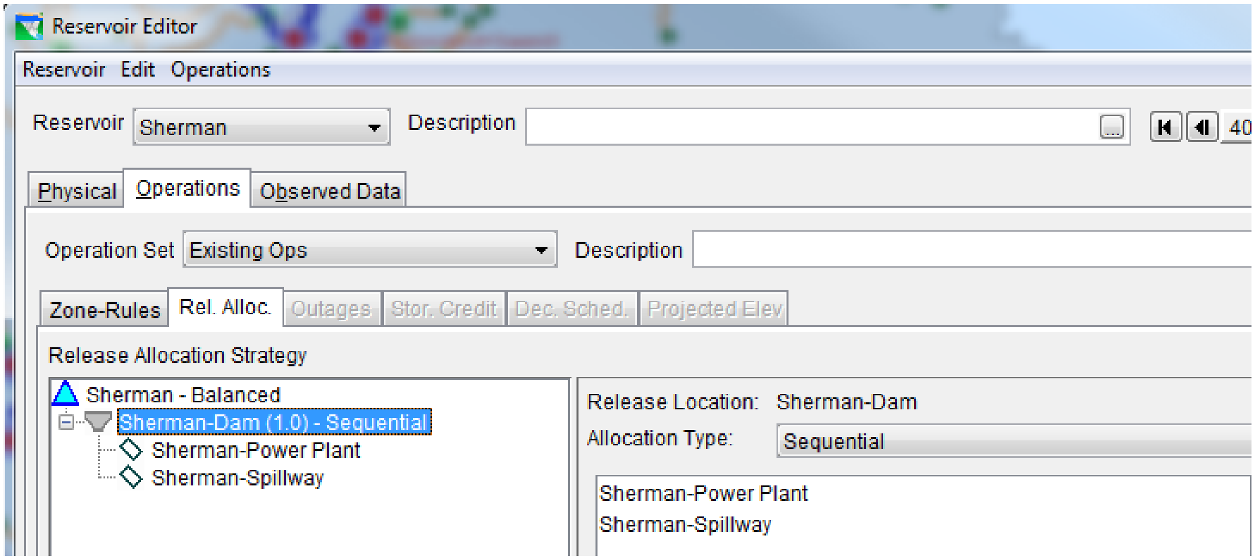


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[88].

.

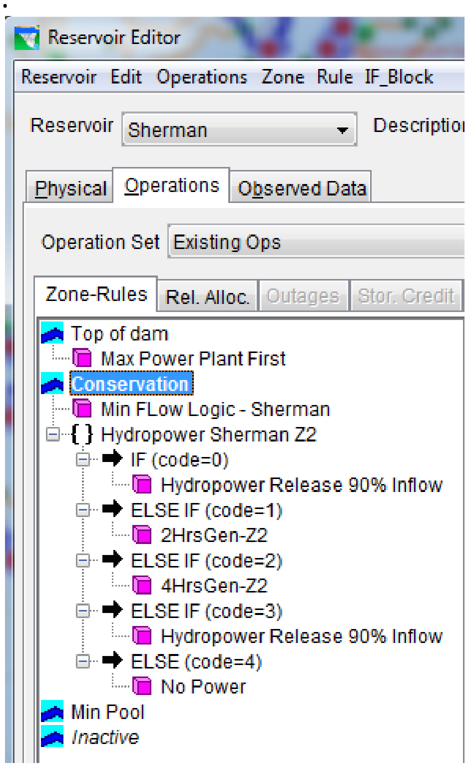


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[88] TransCanada. Deerfield River Operational Constraints. 2012.

C. Rule Descriptions

1. Max Power Plant First

Figure 8 shows the content of "Max Power Plant First" rule. This rule forces the inflow to pass through the power plant first until it reaches the maximum plant capacity.

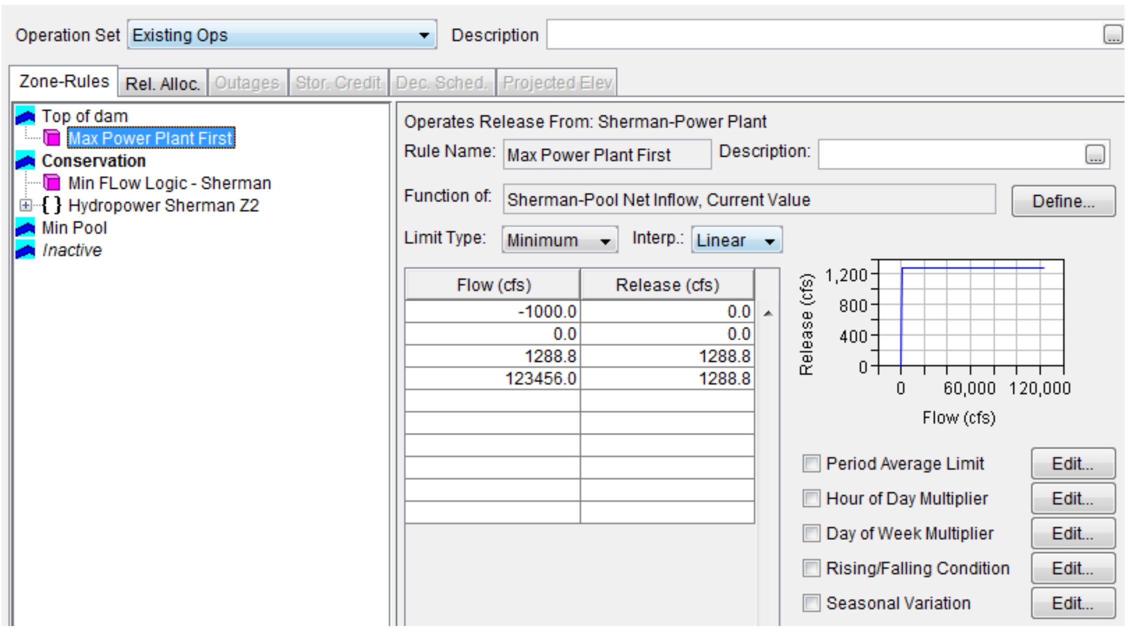


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Power Plant First

2. Min Flow Logic Sherman

This rule represents the minimum release from reservoir as a function of Inflow. The content of the rule is shown in Figure 9.

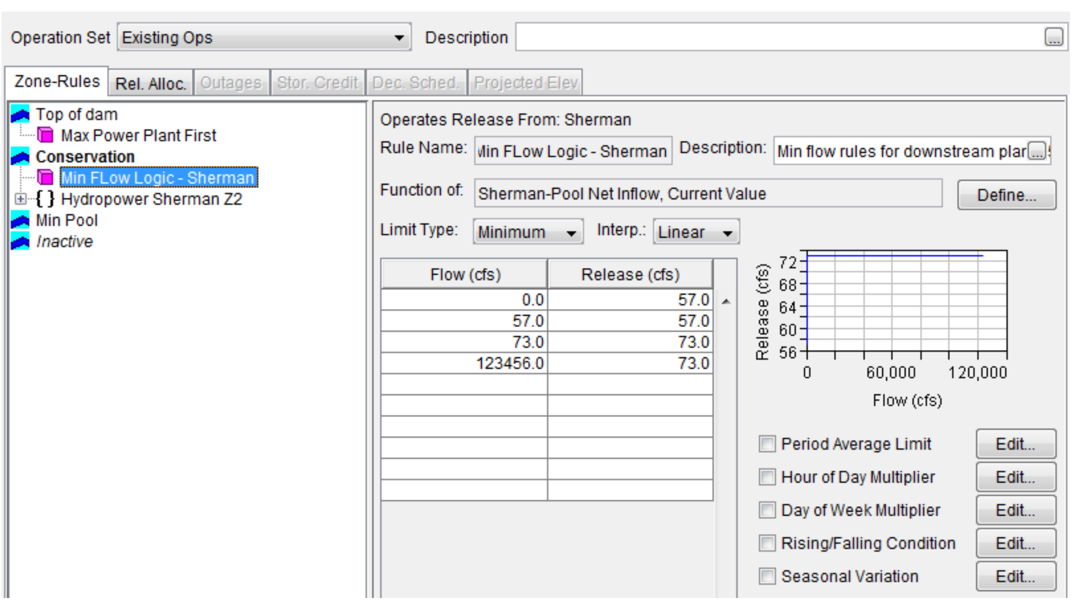
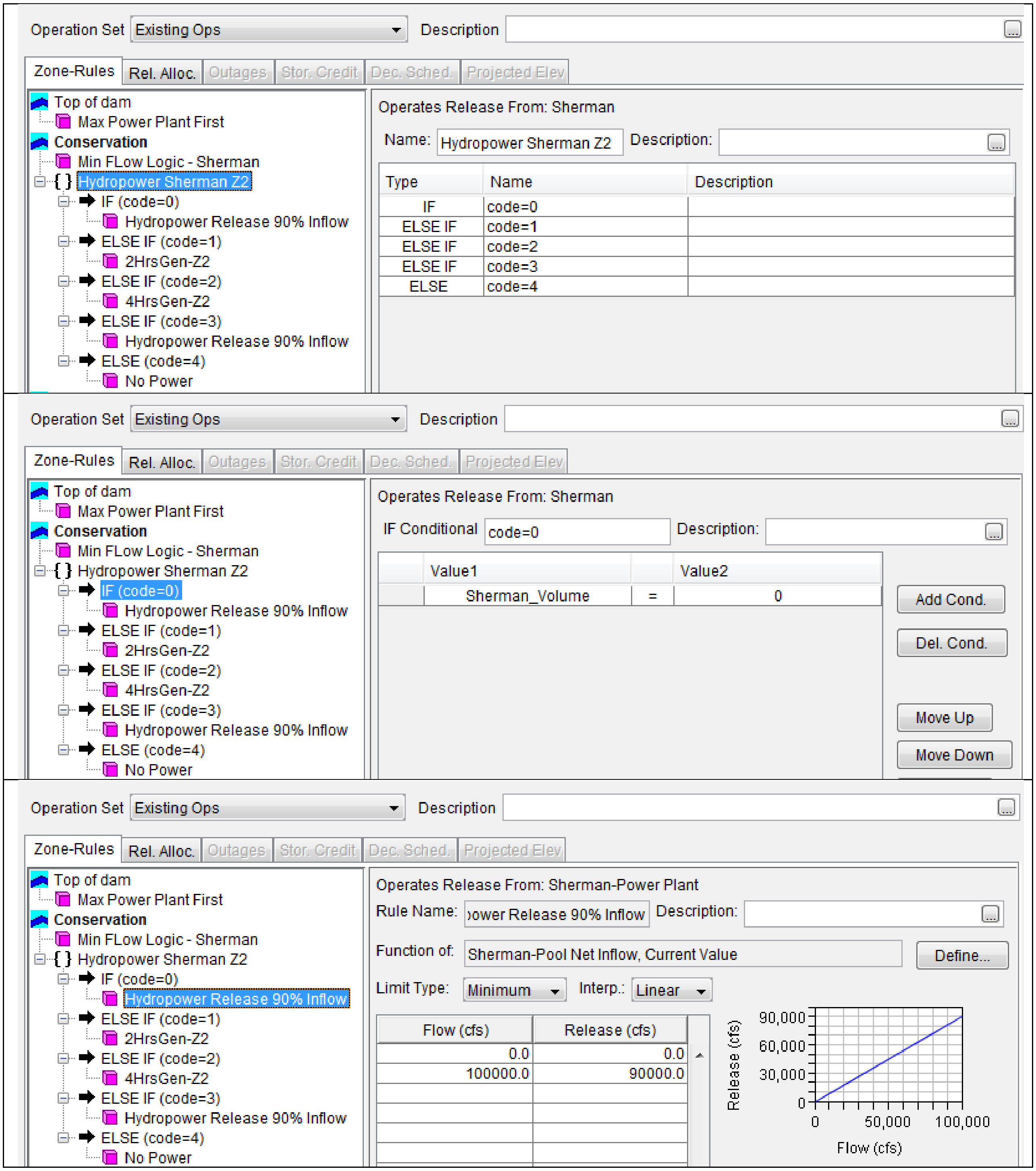
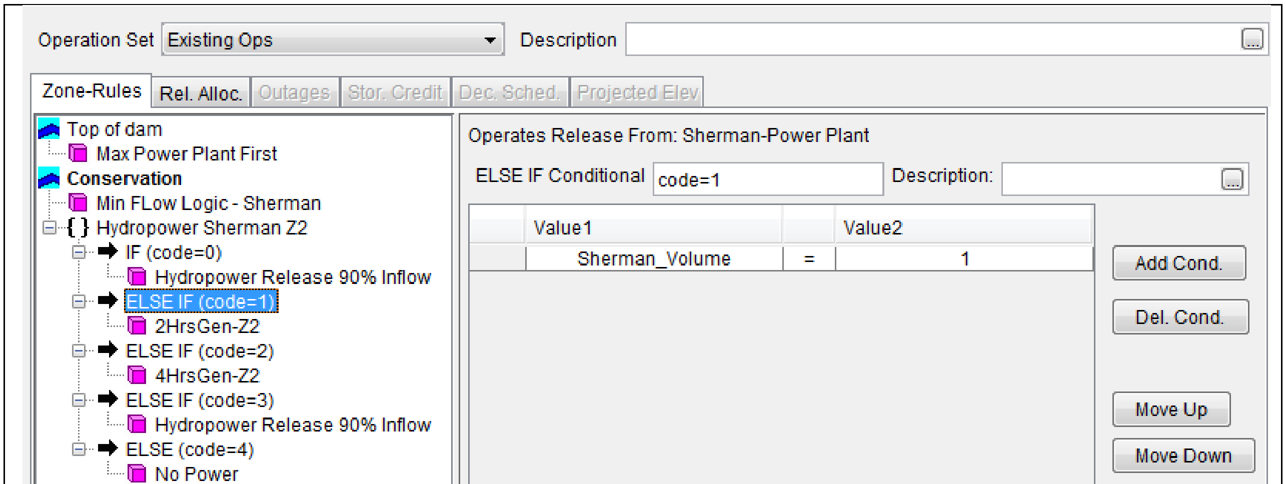


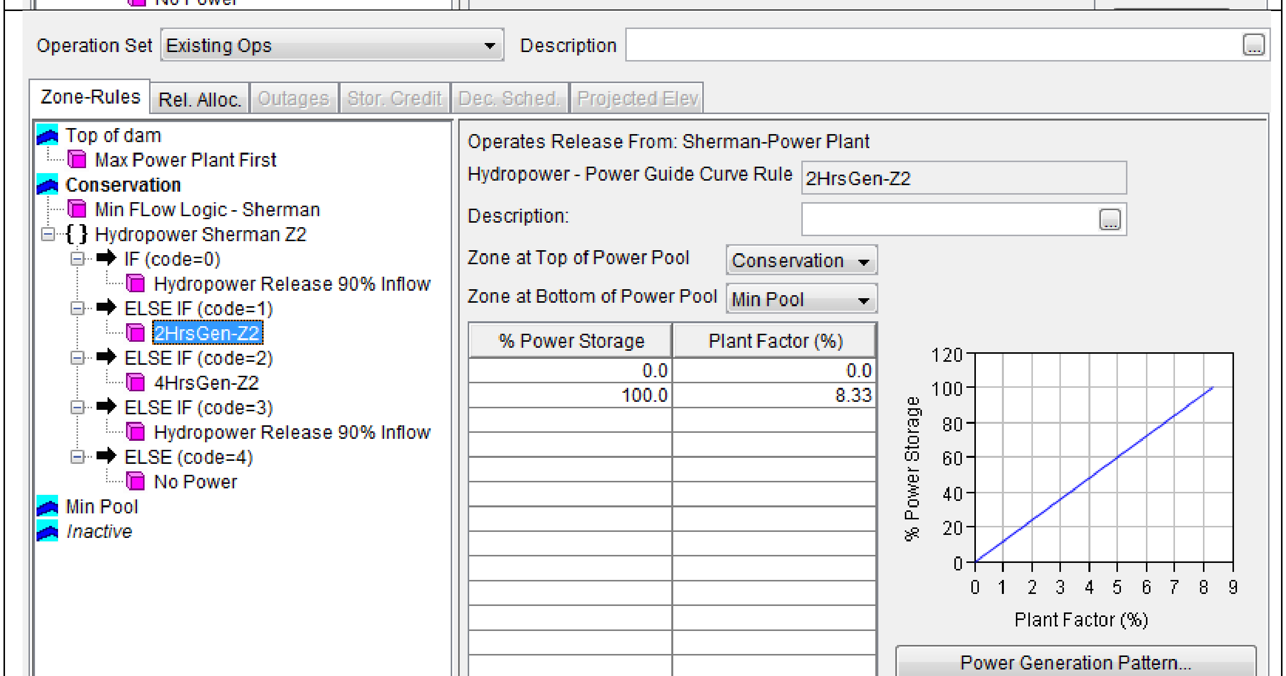
Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic Sherman

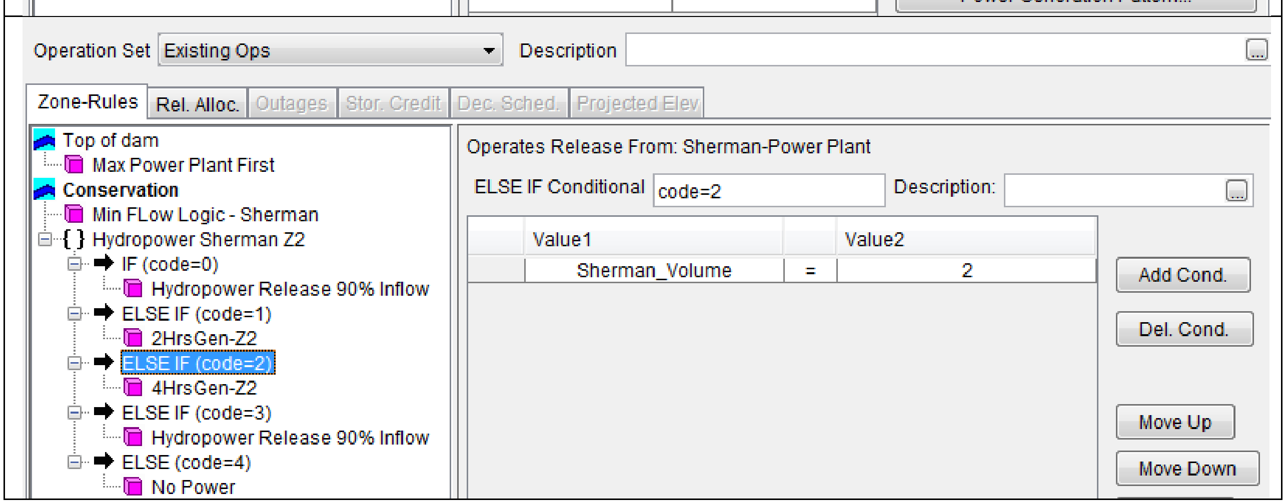
3. *Hydropower Sherman Z2*

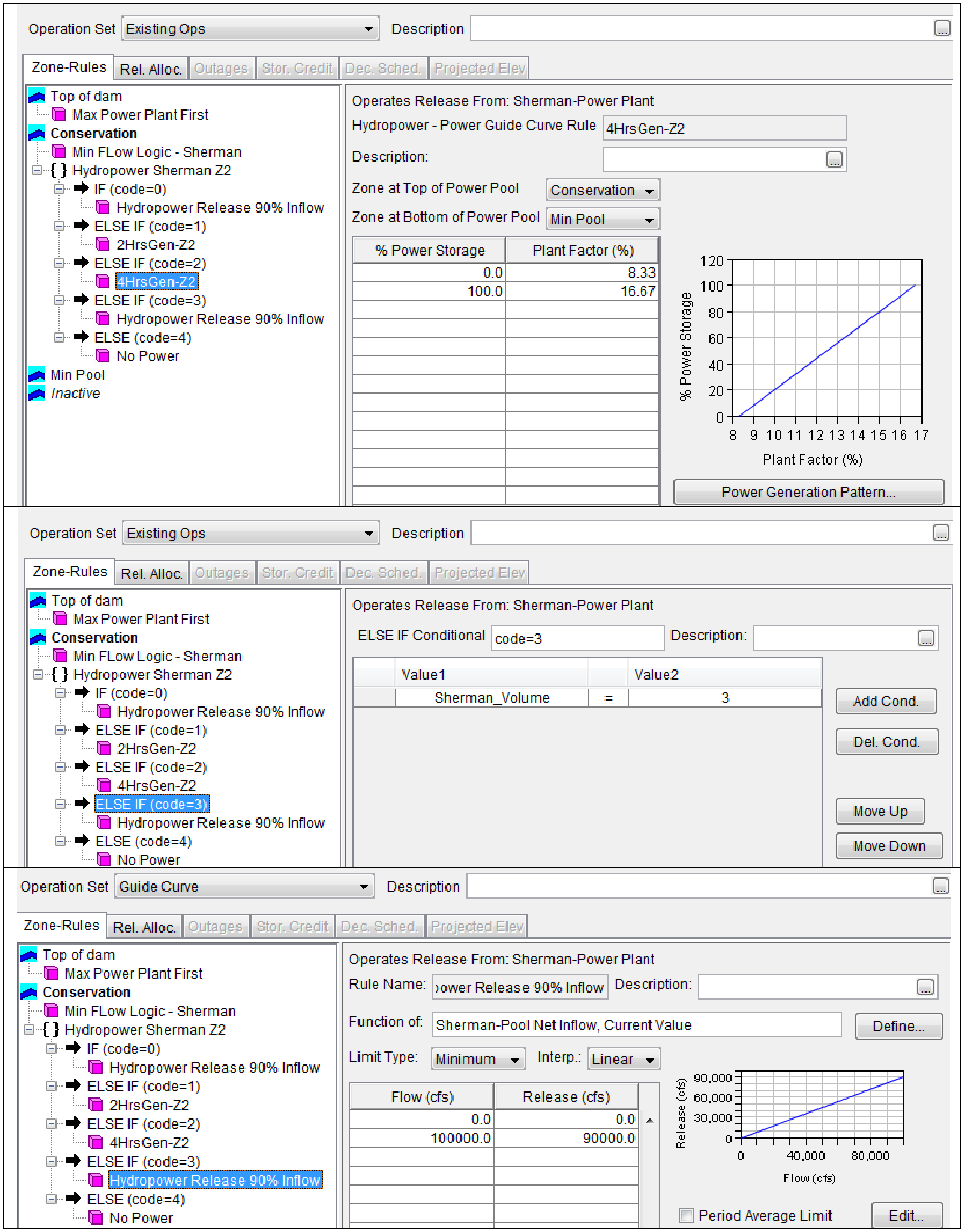
This rule represents power strategy applied for Sherman reservoir. The content of the rule is shown in Figure 10.




Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
Conservation
Min FLow Logic - Sherman
{ } Hydropower Sherman Z2
IF (code=0)
Hydropower Release 90% Inflow
ELSE IF (code=1)
2HrsGen-Z2
ELSE IF (code=2)
4HrsGen-Z2
ELSE IF (code=3)
Hydropower Release 90% Inflow
ELSE (code=4)
No Power
Operates Release From: Sherman-Power Plant
ELSE IF Conditional
code=1
Description:
Value1
Value2
Sherman_Volume
=
1
Add Cond.
Del. Cond.
Move Up
Move Down


Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
Conservation
Min FLow Logic - Sherman
{ } Hydropower Sherman Z2
IF (code=0)
Hydropower Release 90% Inflow
ELSE IF (code=1)
2HrsGen-Z2
ELSE IF (code=2)
4HrsGen-Z2
ELSE IF (code=3)
Hydropower Release 90% Inflow
ELSE (code=4)
No Power
Min Pool
Inactive
Operates Release From: Sherman-Power Plant
Hydropower - Power Guide Curve Rule
2HrsGen-Z2
Description:
Zone at Top of Power Pool
Conservation
Zone at Bottom of Power Pool
Min Pool
% Power Storage
Plant Factor (%)
0.0
0.0
100.0
8.33
120
100
80
60
40
20
0
% Power Storage
0 1 2 3 4 5 6 7 8 9
Plant Factor (%)
Power Generation Pattern...


Operation Set
Existing Ops
Description
Zone-Rules
Rel. Alloc.
Outages
Stor. Credit
Dec. Sched.
Projected Elev
Top of dam
Max Power Plant First
Conservation
Min FLow Logic - Sherman
{ } Hydropower Sherman Z2
IF (code=0)
Hydropower Release 90% Inflow
ELSE IF (code=1)
2HrsGen-Z2
ELSE IF (code=2)
4HrsGen-Z2
ELSE IF (code=3)
Hydropower Release 90% Inflow
ELSE (code=4)
No Power
Operates Release From: Sherman-Power Plant
ELSE IF Conditional
code=2
Description:
Value1
Value2
Sherman_Volume
=
2
Add Cond.
Del. Cond.
Move Up
Move Down


Operation Set Existing Ops
Description
Zone-Rules Rel. Alloc. Outages Stor. Credit Dec. Sched. Projected Elev
Top of dam
Max Power Plant First
Conservation
Min FLow Logic - Sherman
Hydropower Sherman Z2
IF (code=0)
Hydropower Release 90% Inflow
ELSE IF (code=1)
2HrsGen-Z2
ELSE IF (code=2)
4HrsGen-Z2
ELSE IF (code=3)
Hydropower Release 90% Inflow
ELSE (code=4)
No Power
Min Pool
Inactive
Operates Release From: Sherman-Power Plant
Hydropower - Power Guide Curve Rule 4HrsGen-Z2
Description:
Zone at Top of Power Pool Conservation
Zone at Bottom of Power Pool Min Pool
% Power Storage Plant Factor (%)
0.0 8.33
100.0 16.67
% Power Storage
Plant Factor (%)
Power Generation Pattern...
Operation Set Existing Ops
Operates Release From: Sherman-Power Plant
ELSE IF Conditional code=3
Value1 Value2
Sherman_Volume = 3
Add Cond.
Del. Cond.
Move Up
Move Down
Operation Set Guide Curve
Operates Release From: Sherman-Power Plant
Rule Name: ›ower Release 90% Inflow
Function of: Sherman-Pool Net Inflow, Current Value
Define...
Limit Type: Minimum
Interp.: Linear
Flow (cfs) Release (cfs)
0.0 0.0
100000.0 90000.0
Release (cfs)
Flow (cfs)
Period Average Limit
Edit...

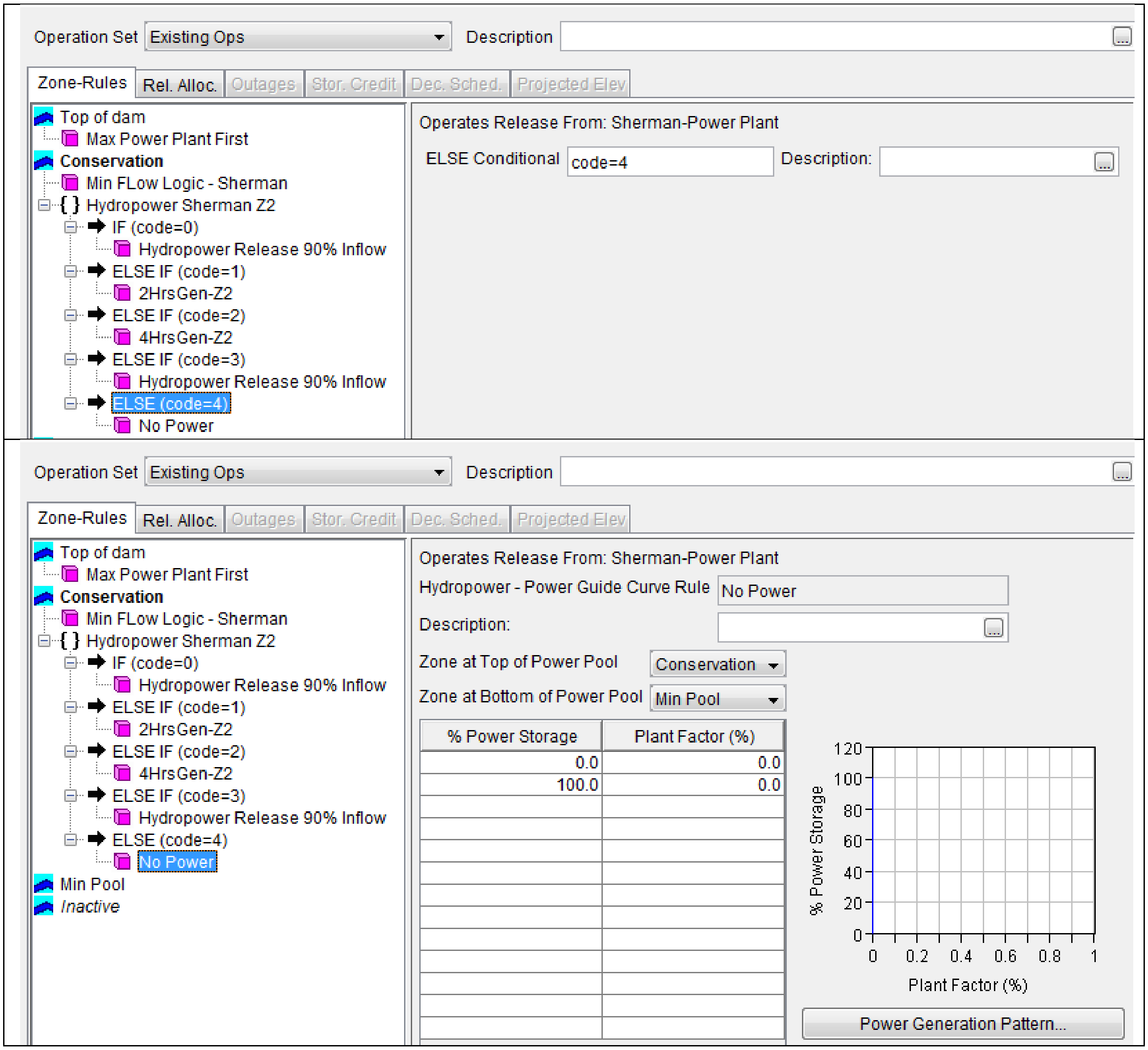


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Hydropower Sherman Z2

Figure 11 describes the definition of codes used in the Sherman_Volume state variable. The code is summing up the current Inflow and previous storage in each time step, compare it to the volume needed for generating 2 and 4 hours power and to the spillway storage minus inactive storage and then decide how much to release.

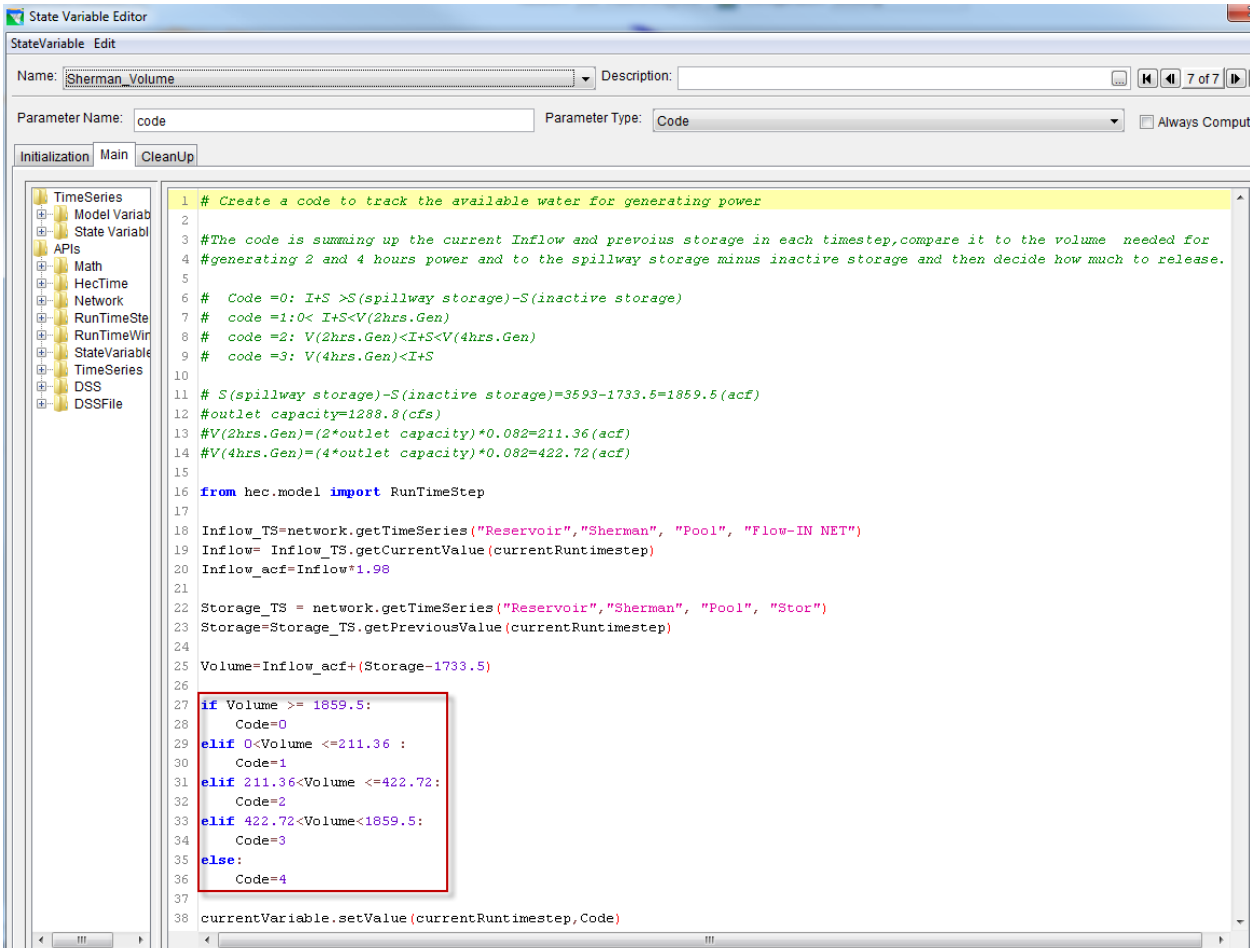


Figure 11: State Variable Editor: Sherman_Volume

Shuttle Meadow

II. Overview

Shuttle Meadow dam is located on the upper reaches of Willow Brook in the towns of New Britain and Southington, CT. The dam is owned and operated by the two towns and is used for water supply.

Figure 1 shows the location of Shuttle Meadow dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Shuttle Meadow dam.

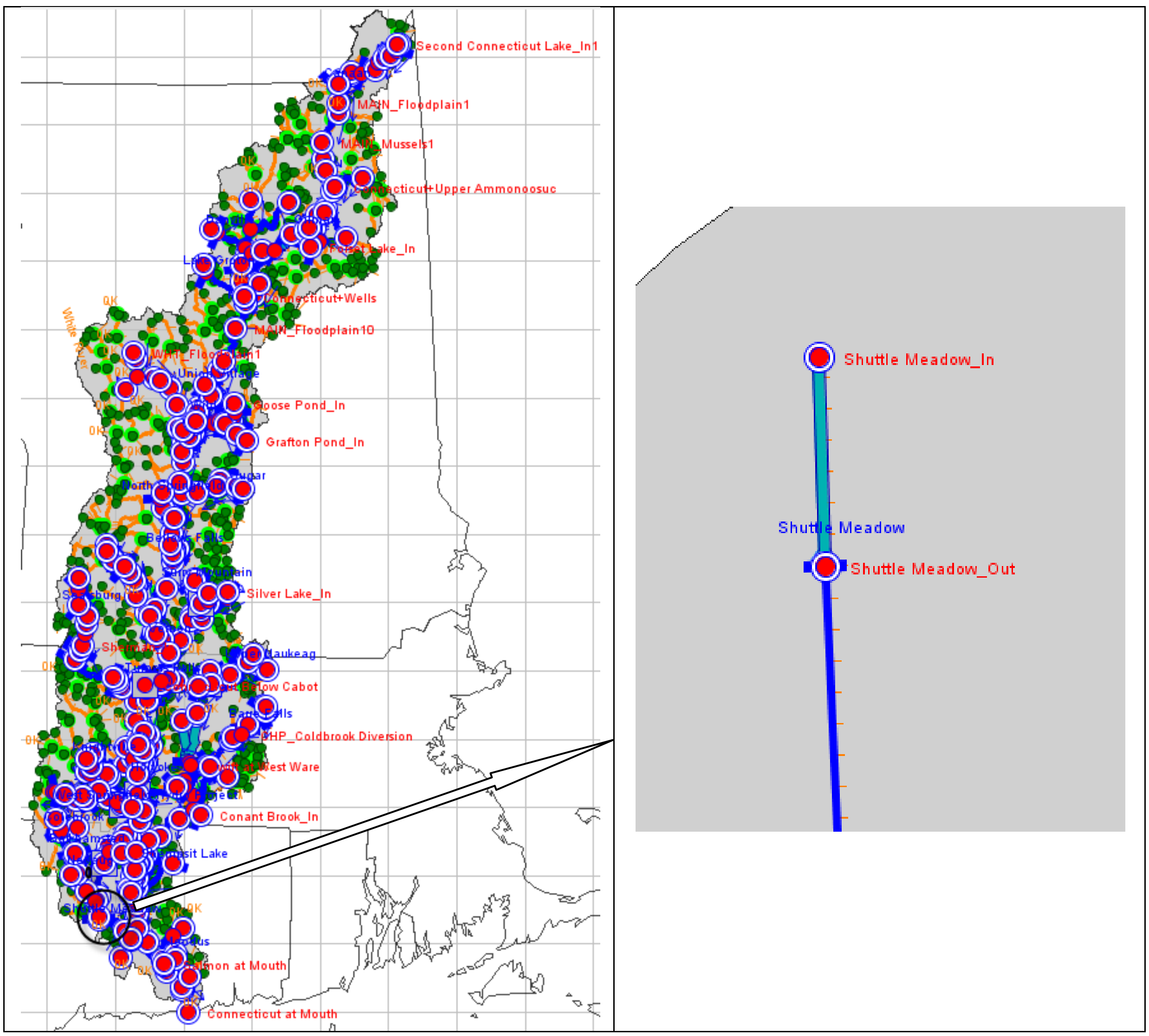


Figure 1: HEC-ResSim Map Display Showing Location of Shuttle meadow


Figure 2: Photo of Shuttle Meadow dam.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[89]. The dam consists of an uncontrolled spillway as shown in Figure 4.

[89] Data provided by the Town of New Britain.

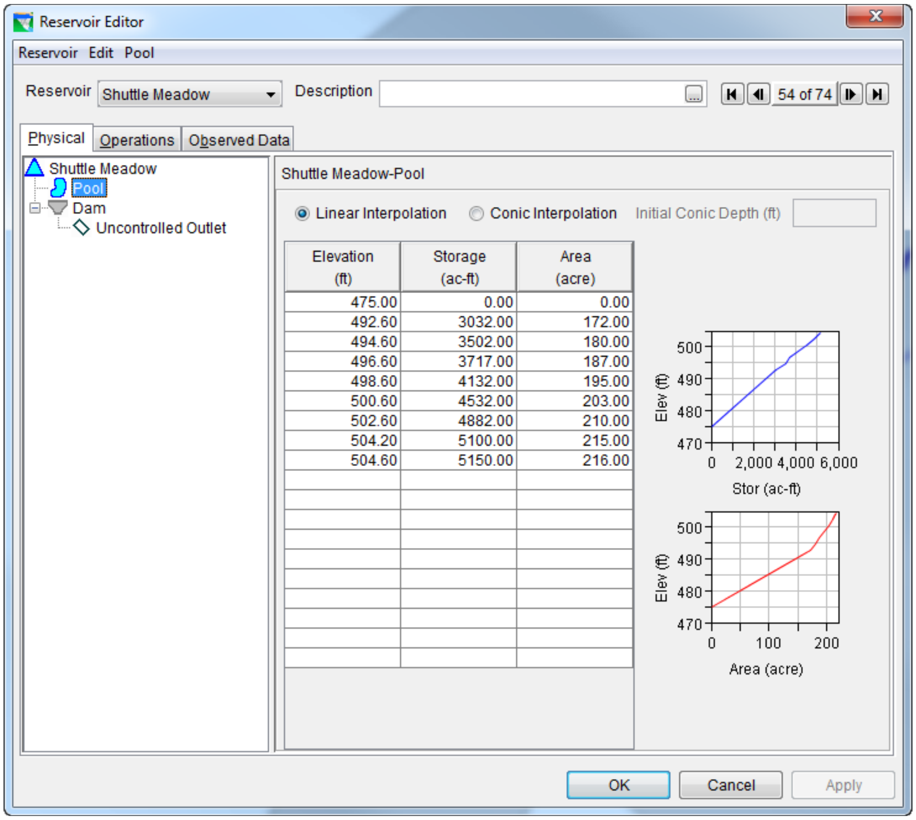


Figure 3: Reservoir Editor: Physical Tab -- Pool

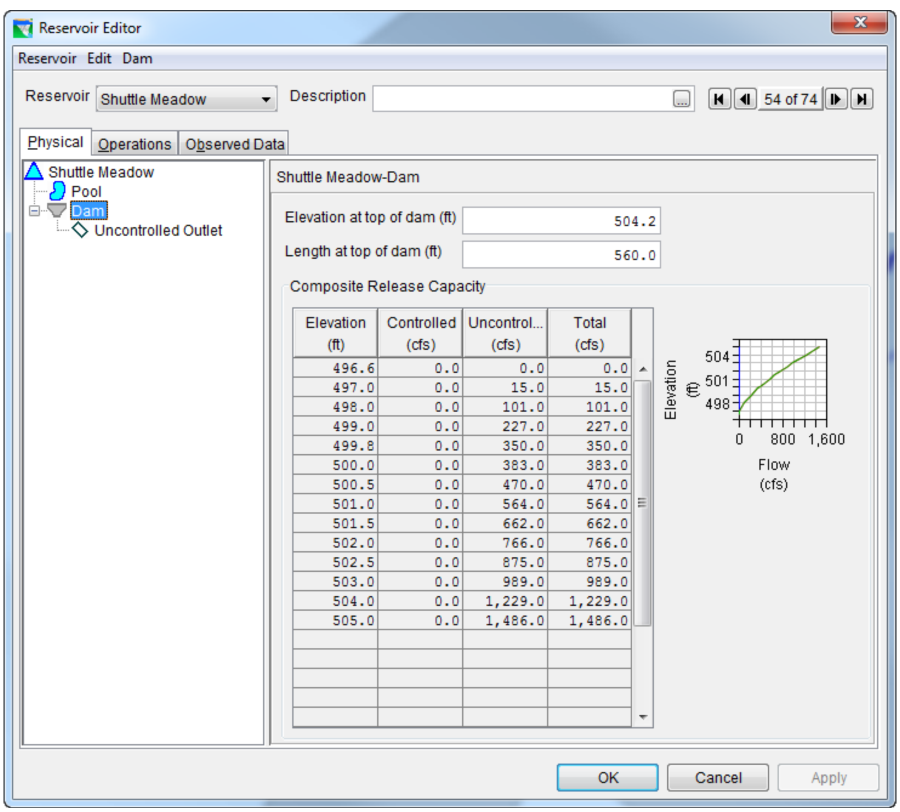


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Shuttle Meadow's "Guide Curve" operational zones, which consist of zones of Flood control (498 ft), Conservation (496 ft), and Inactive zone (480 ft).

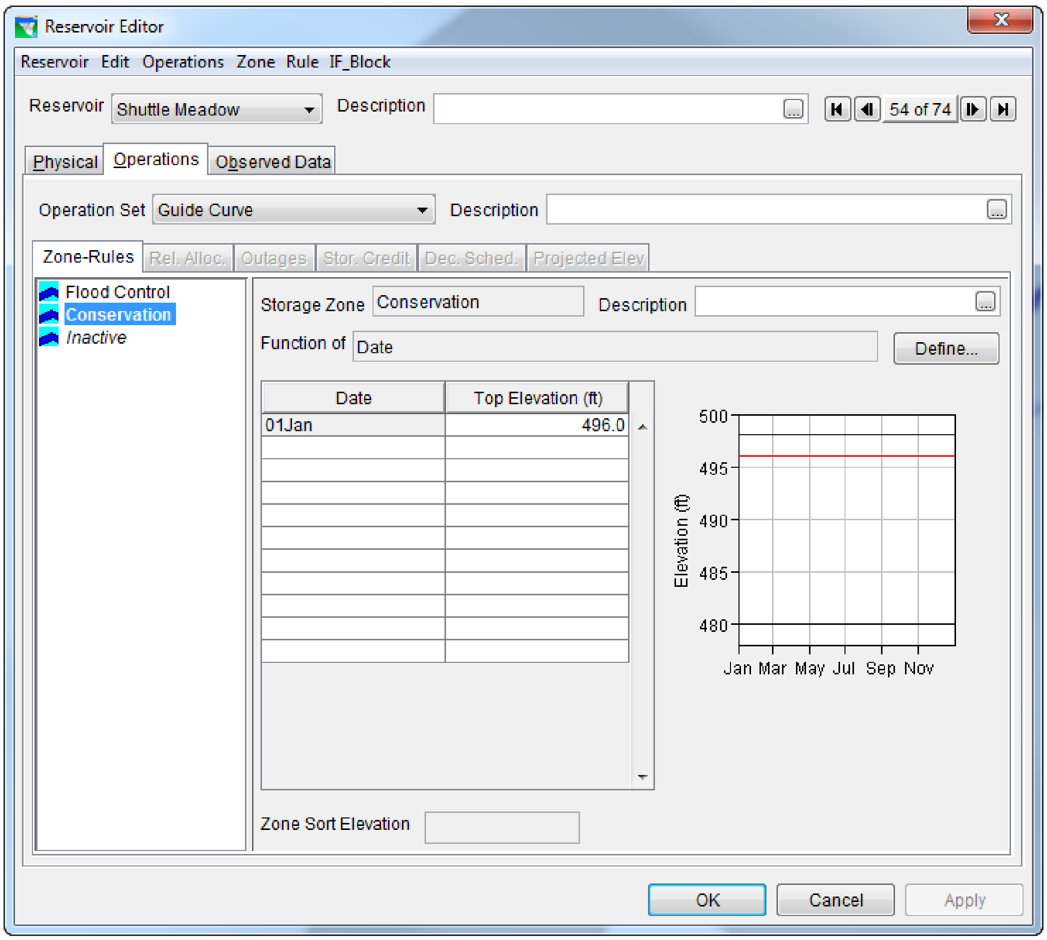


Figure 5: Reservoir Editor: Operations Tab – Guide Curve OpSet

B. Rule Illustrations

The operation set for Shuttle meadow has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity. There is a water supply time series for Shuttle Meadow. Daily water withdrawal and return flows for the year 2009 were provided by the New Britain Water District. These daily withdrawals were used to create a water supply time series for the model period of record.

Silver Lake

I. Overview

Silver Lake dam is located in the Town of Harrisville, NH and forms the headwaters of Minnewawa Brook. This dam is owned and operated by the State of New Hampshire Water Resources Board. It is primarily used for recreation with also some flood control benefits.

Figure 1 shows the location of Silver lake dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Silver Lake dam.

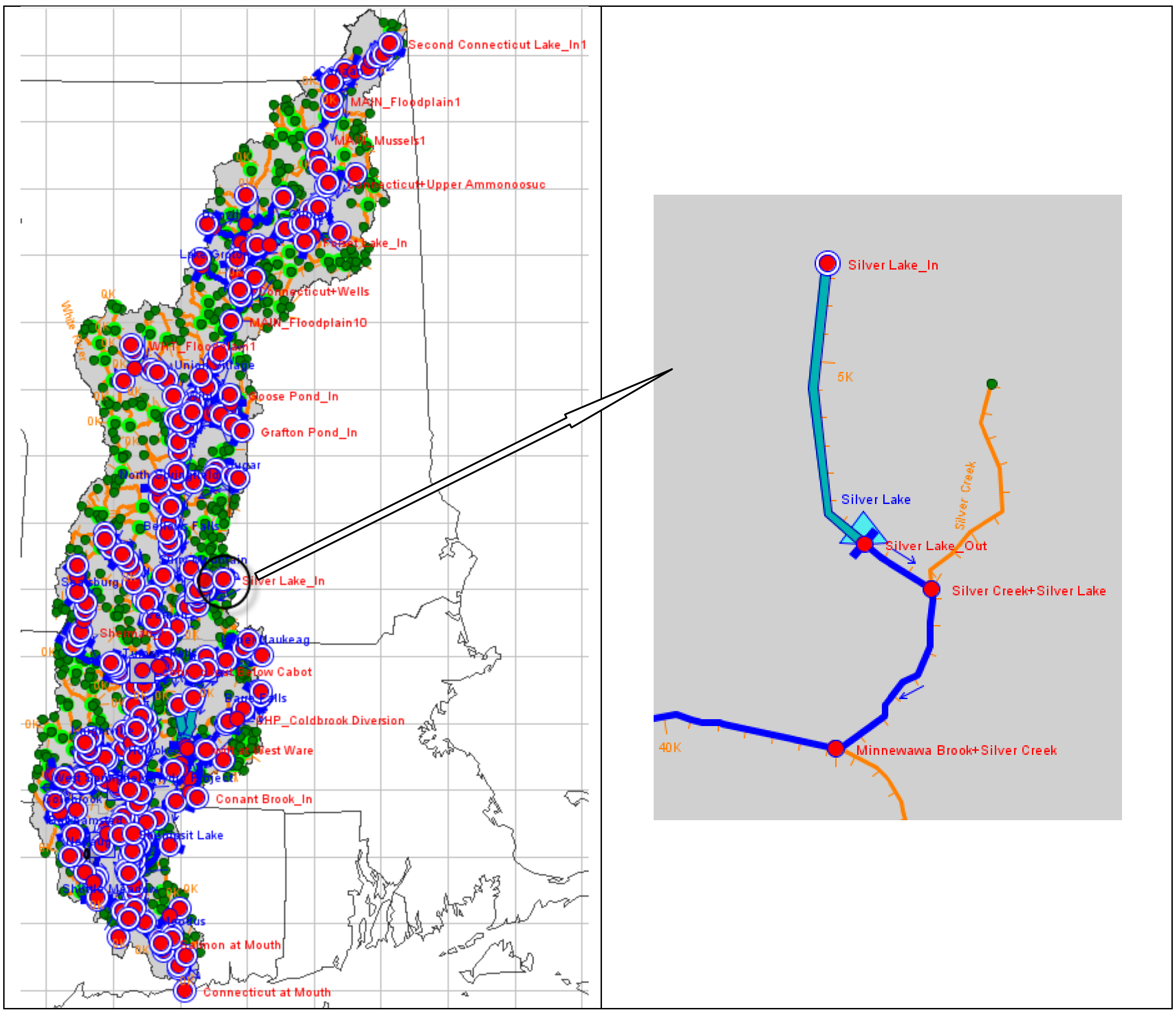


Figure 1: HEC-ResSim Map Display Showing Location of Silver lake

Figure 2: Photo of Silver Lake

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[90]. The dam consists of a controlled and an uncontrolled outlet as shown in Figure 4[91].

[90] NHDams Data Sheet. Silver Lake. 2007
[91] New Hampshire Water Resources Board. 1978

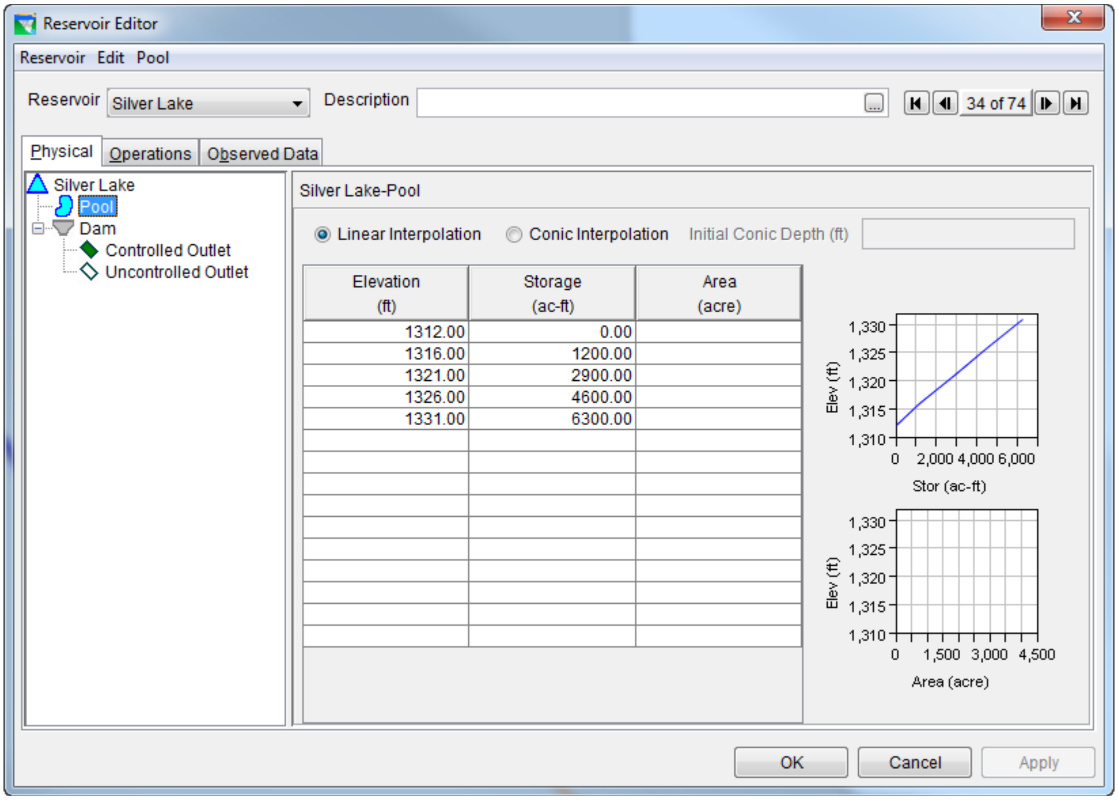


Figure 3: Reservoir Editor: Physical Tab -- Pool

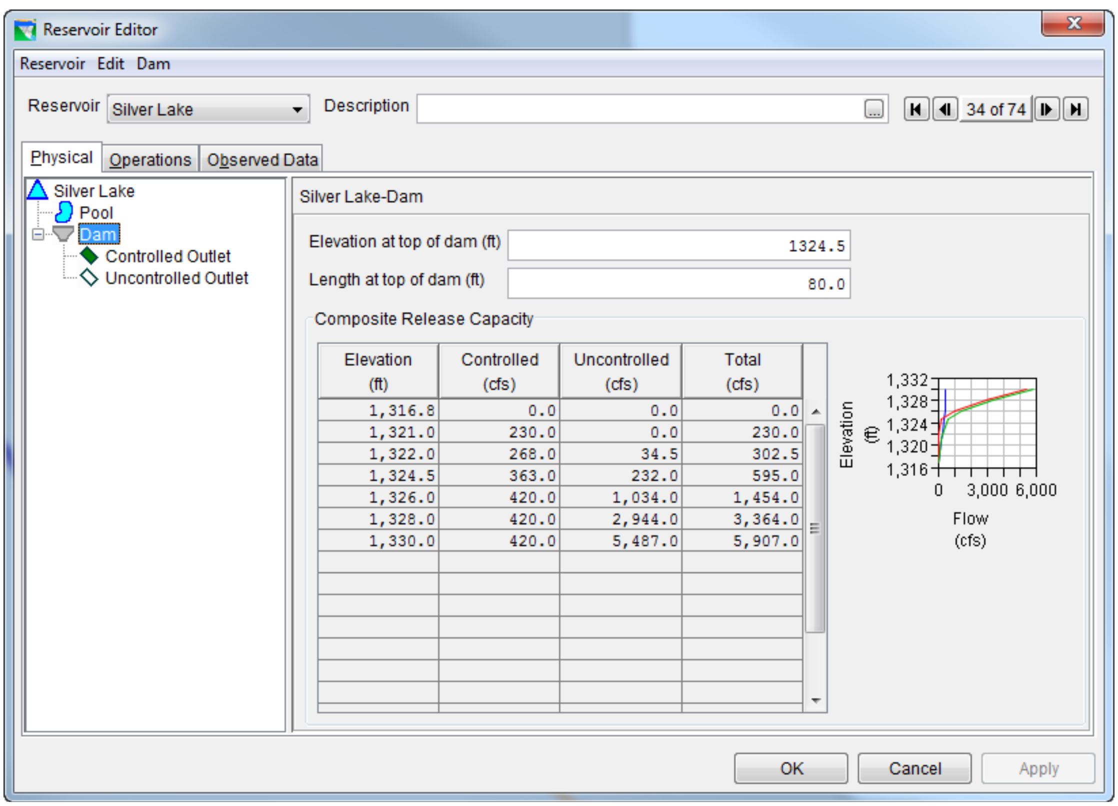


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Bashan's "Guide Curve" operational zones, which consist of zones of Flood Control (1322 ft), Conservation (1318-1321 ft), and Inactive zone (1315 ft)[1].

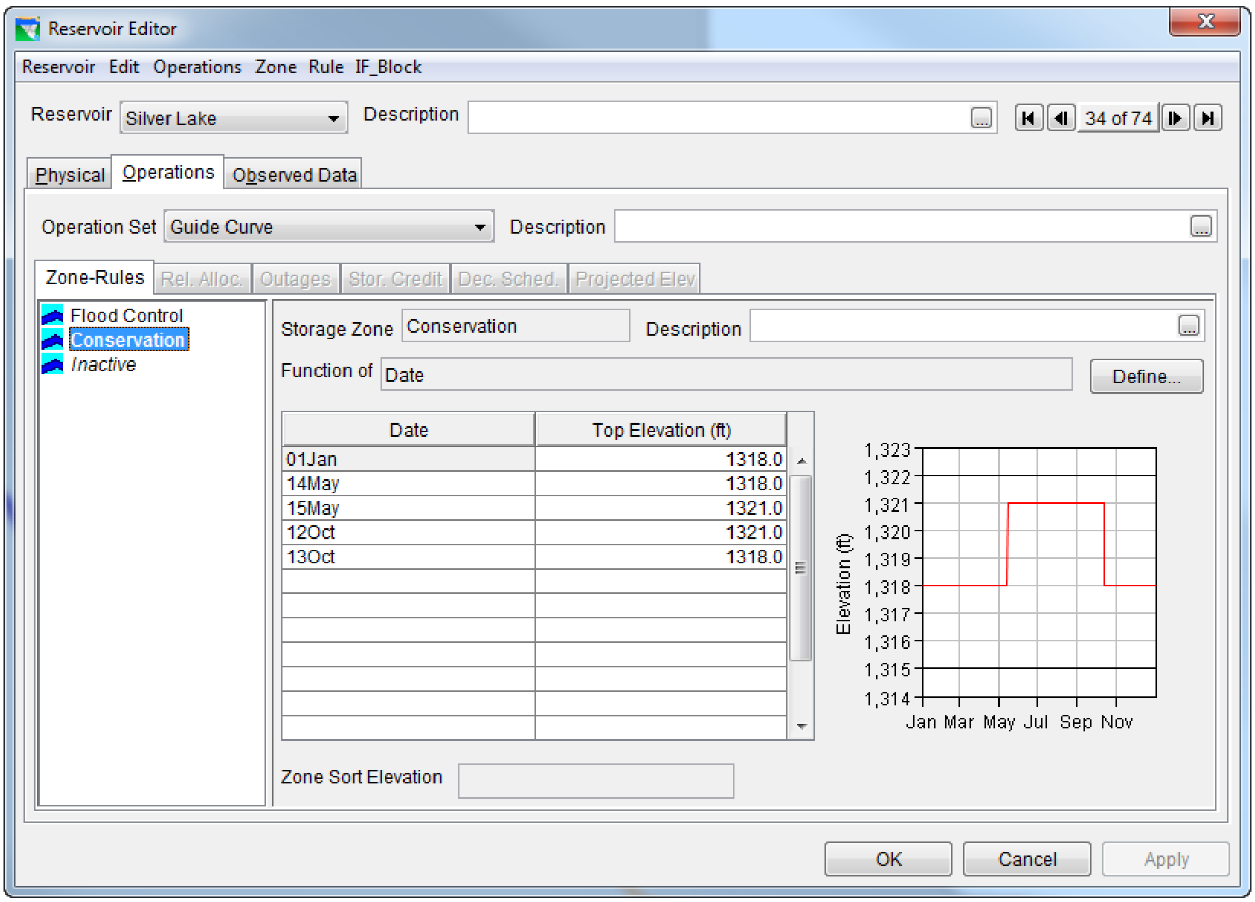


Figure 5: Reservoir Editor: Operations Tab – Guide Curve OpSet

B. Rule Illustrations

The operation set for Silver Lake has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Somerset

I. Overview

Somerset dam is located on the East Branch of the Deerfield River, and is the furthest upstream. It is owned and operated by TransCanada Hydro Northeast Inc. as a storage reservoir to make releases to its downstream hydro facilities.

Figure 1 shows the location of Somerset Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo from Somerset dam.

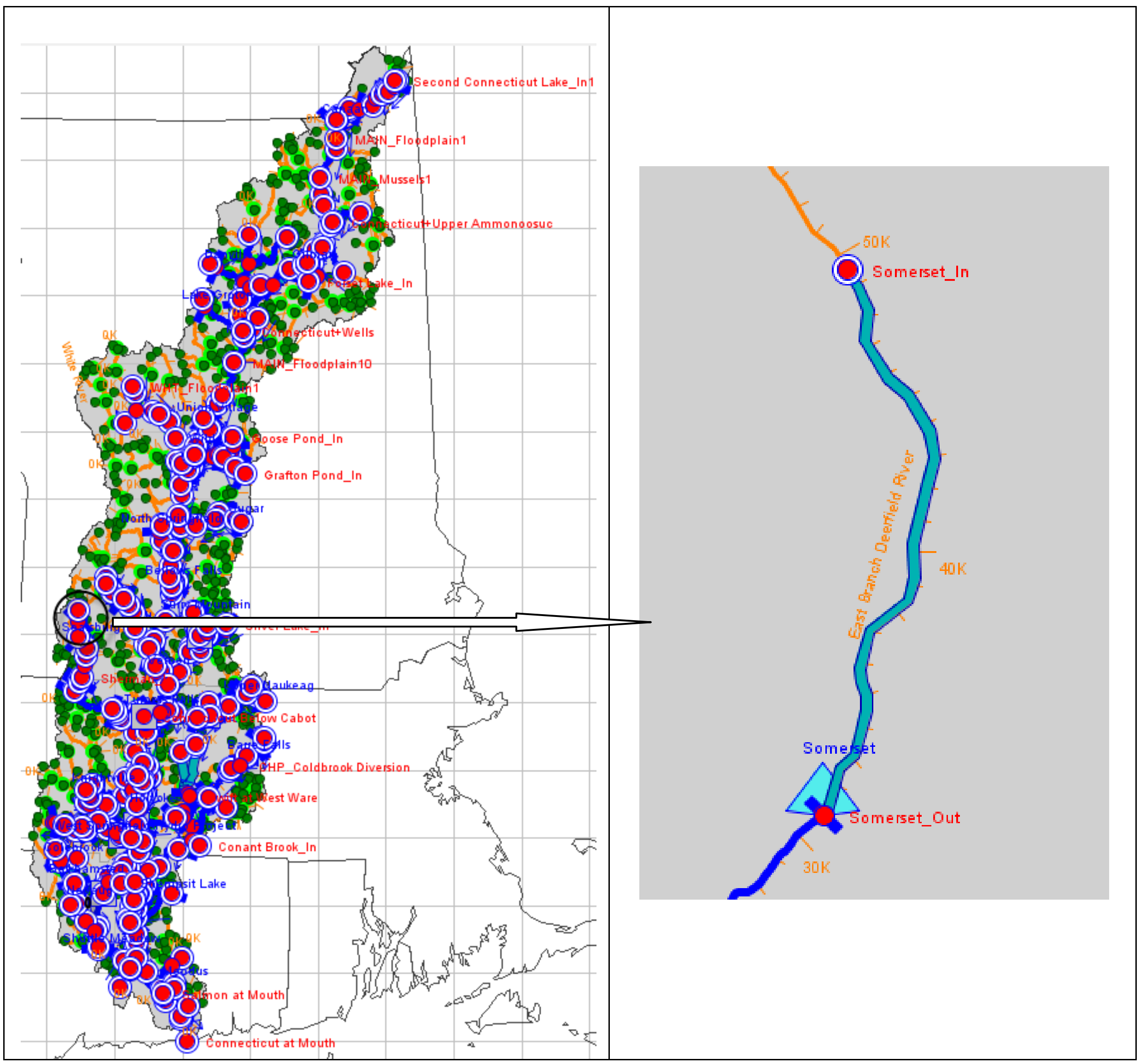


Figure 1: HEC-ResSim Map Display Showing Location of Somerset

Figure 2: Photo of Somerset Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[92]. The dam consists of four types of outlets: (1) controlled outlet, (2) uncontrolled outlet, (3) 14 inch valve, and (4) 42 inch valve as shown in Figure 4.

.

[92] Data provided by TransCanada

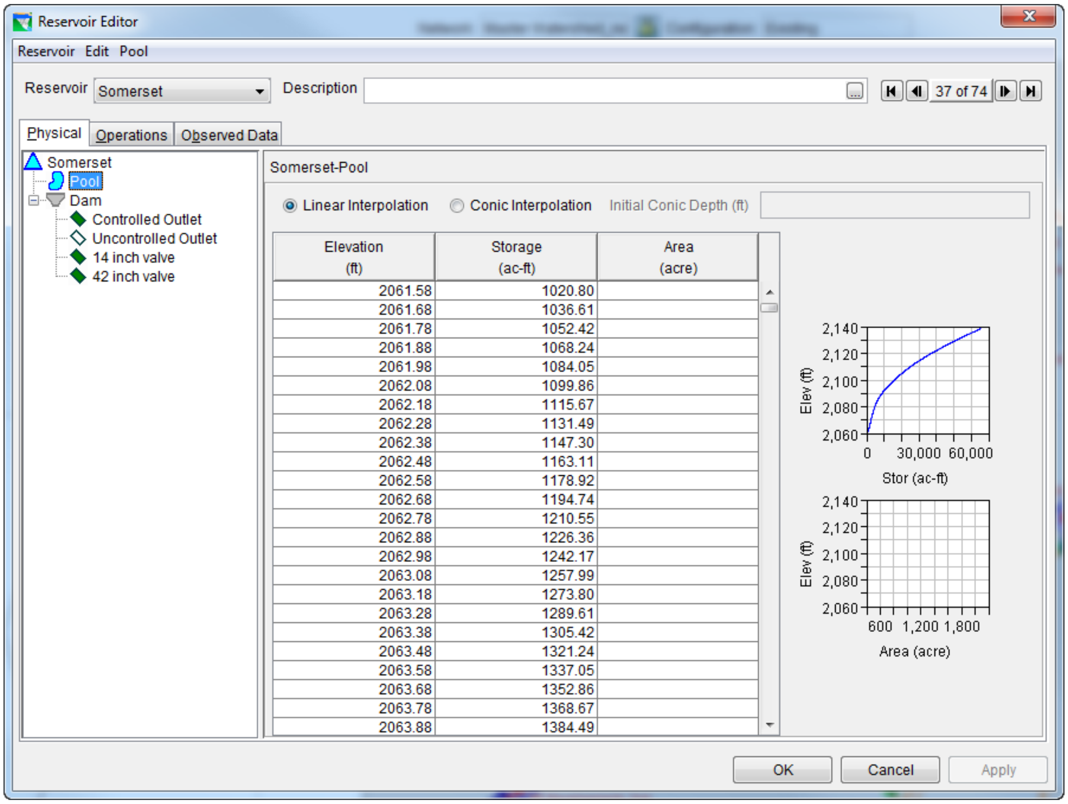


Figure 3: Reservoir Editor: Physical Tab -- Pool

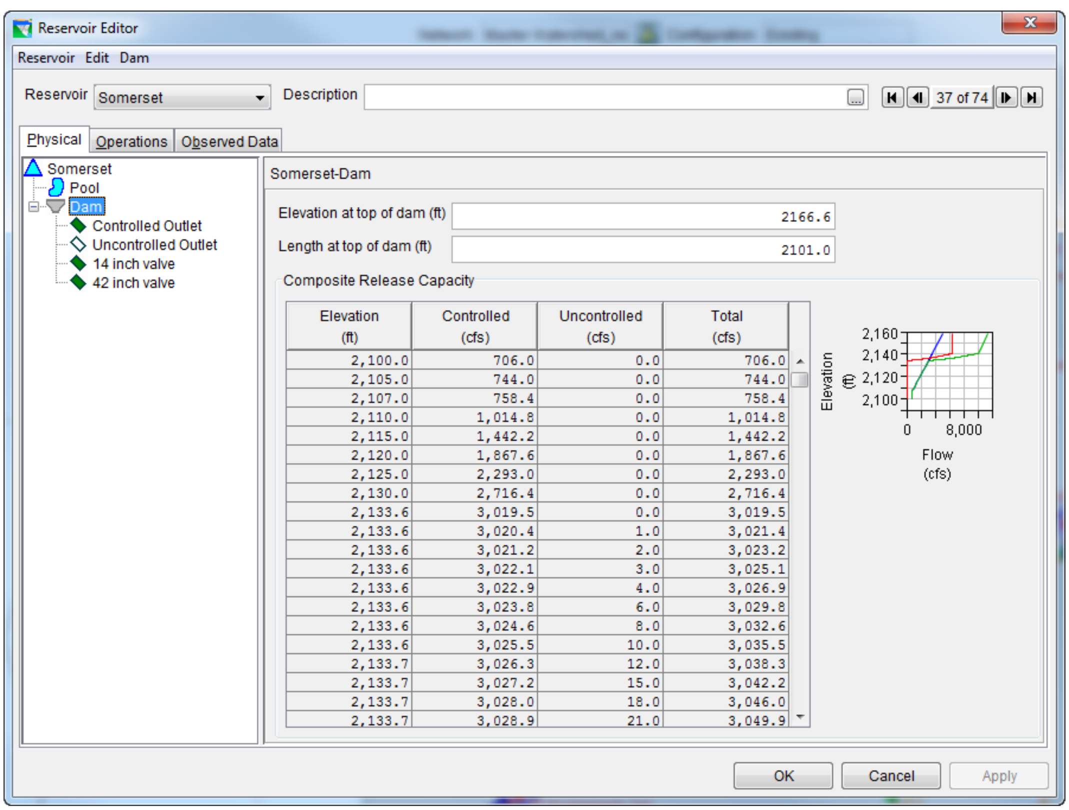


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Somerset's "ExistingOps" operational zones, which consist of zones of Top of dam (2166.6 ft), conservation (2131-2136.6 ft), Min Pool (2107 ft), and Inactive zone (2048.1 ft)[1].

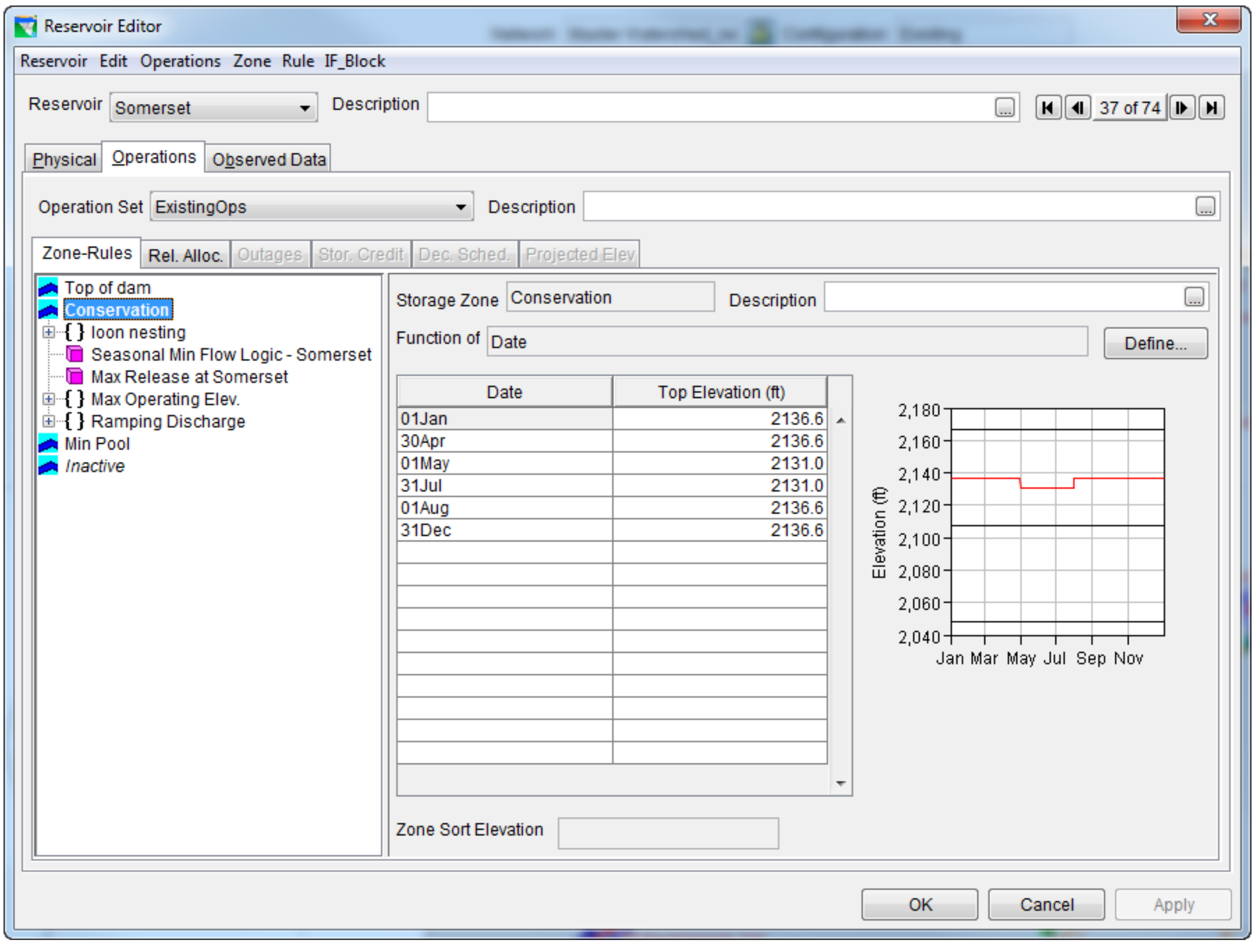


Figure 5 Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

Figure 6 shows a sequential release allocation approach specified for available outlets along Harriman Dam. The available outlets are given an order of priority for release. The controlled outlet gets the release first until it reaches release capacity. The 14 inch valve and 42 incj valve gets the remainder of the release.

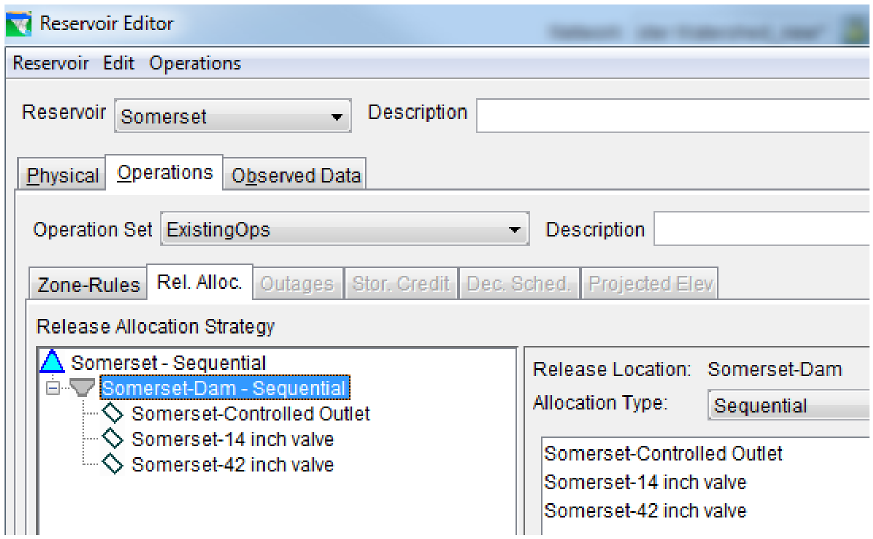


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

B. Rule Illustrations

Figure 7 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[93].

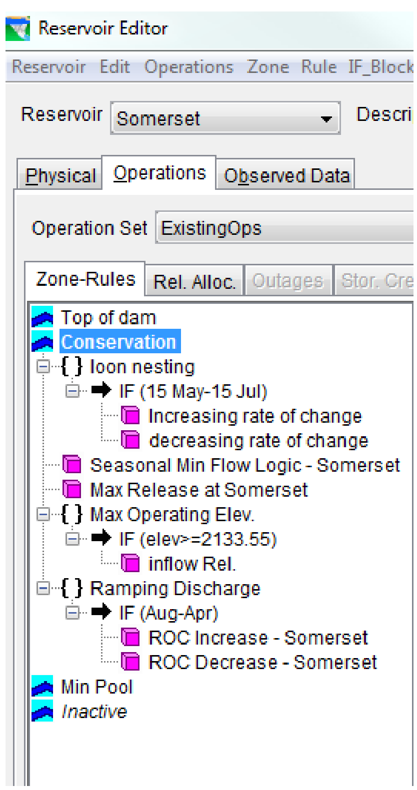


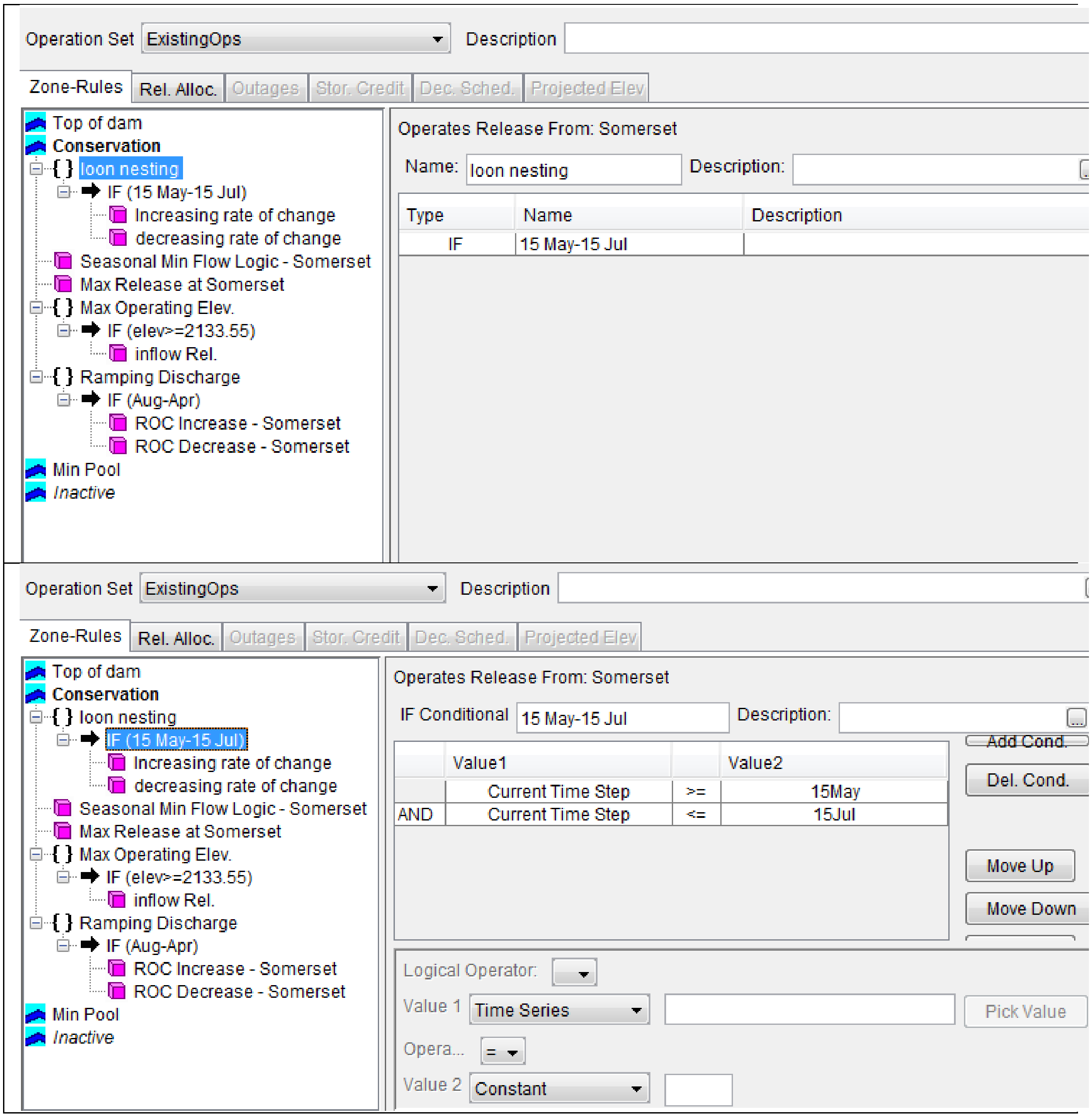
Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[93] TransCanada. Deerfield River Operational Constraints. 2012.

C. Rule Descriptions

1. Loon nesting

Figure 8 shows the content of “loon nesting” rule. This rule limits the maximum and minimum rate of elevation change to one foot per 1440 hours during May15-Jul 15.



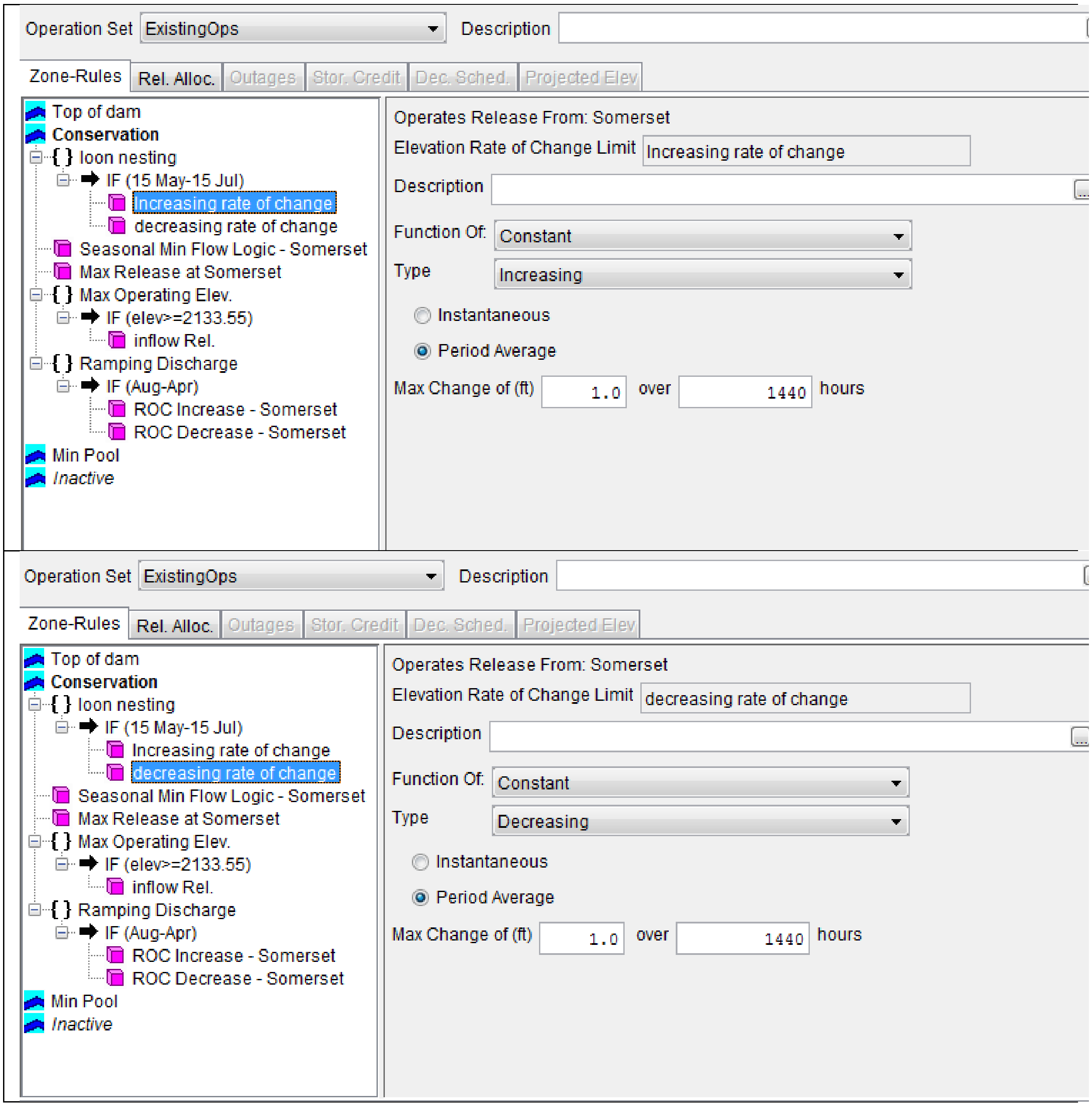


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – loon nesting

2. *Seasonal Min Flow Logic-Somerset*

Figure 9 shows the content of "Seasonal Min Flow Logic-Somerset" rule. This rule represents the seasonal minimum flow from reservoir as a function of Inflow.

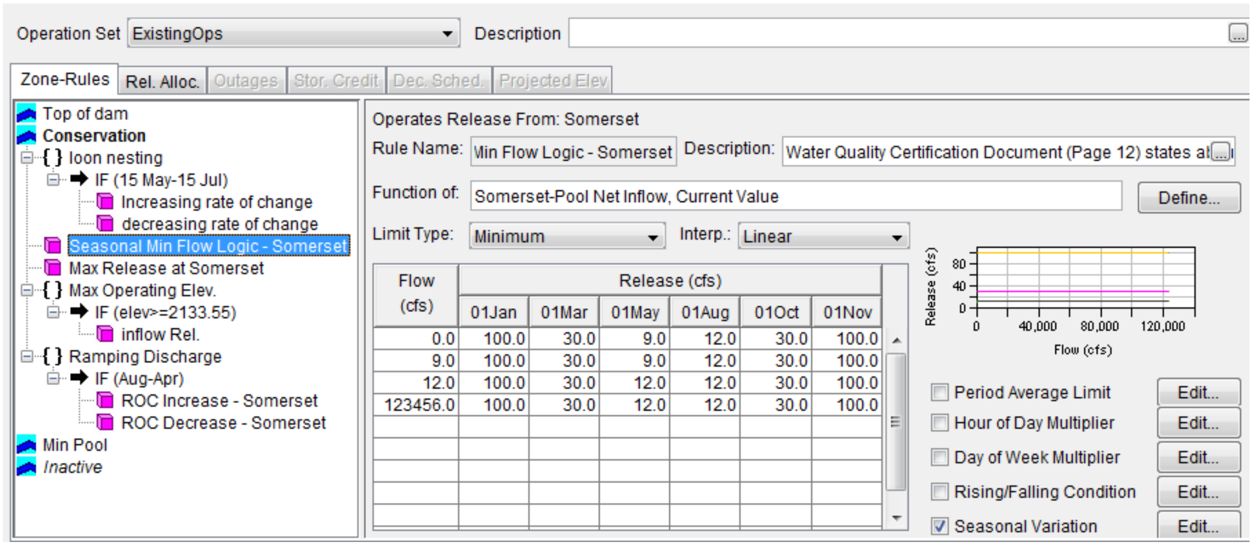


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Seasonal Min Flow Logic-Somerset

3. *Max Release at Somerset*

Figure 10 shows the content of "Max Release at Somerset" rule. This rule represents the seasonal maximum flow from reservoir based on Inflow.

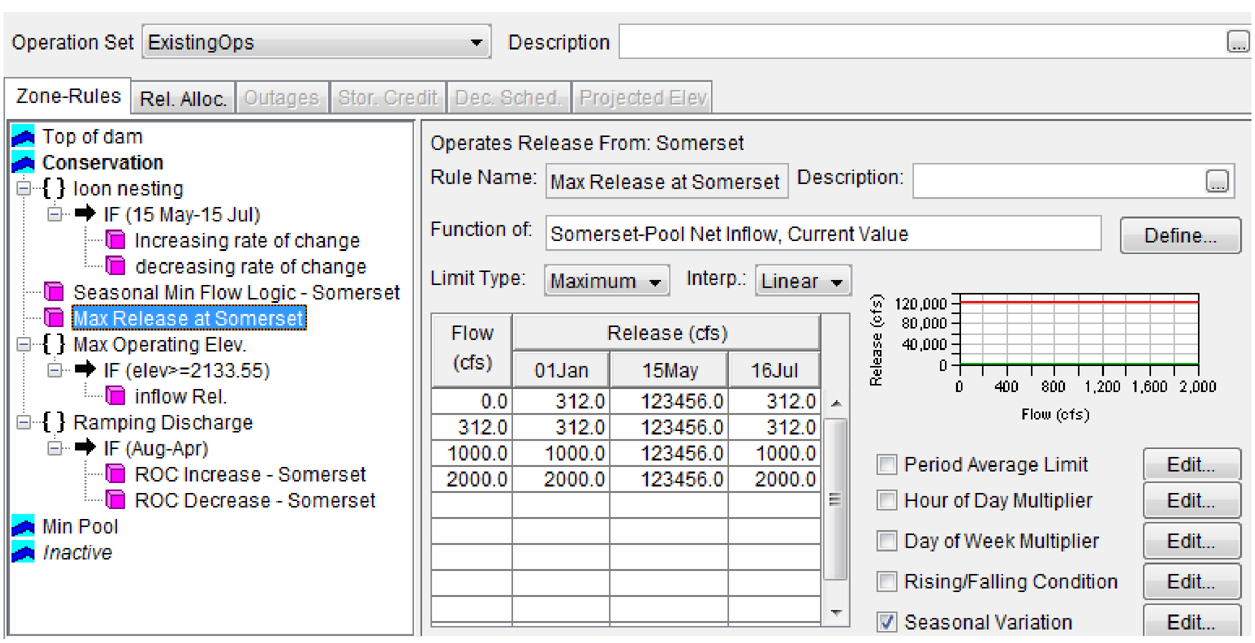
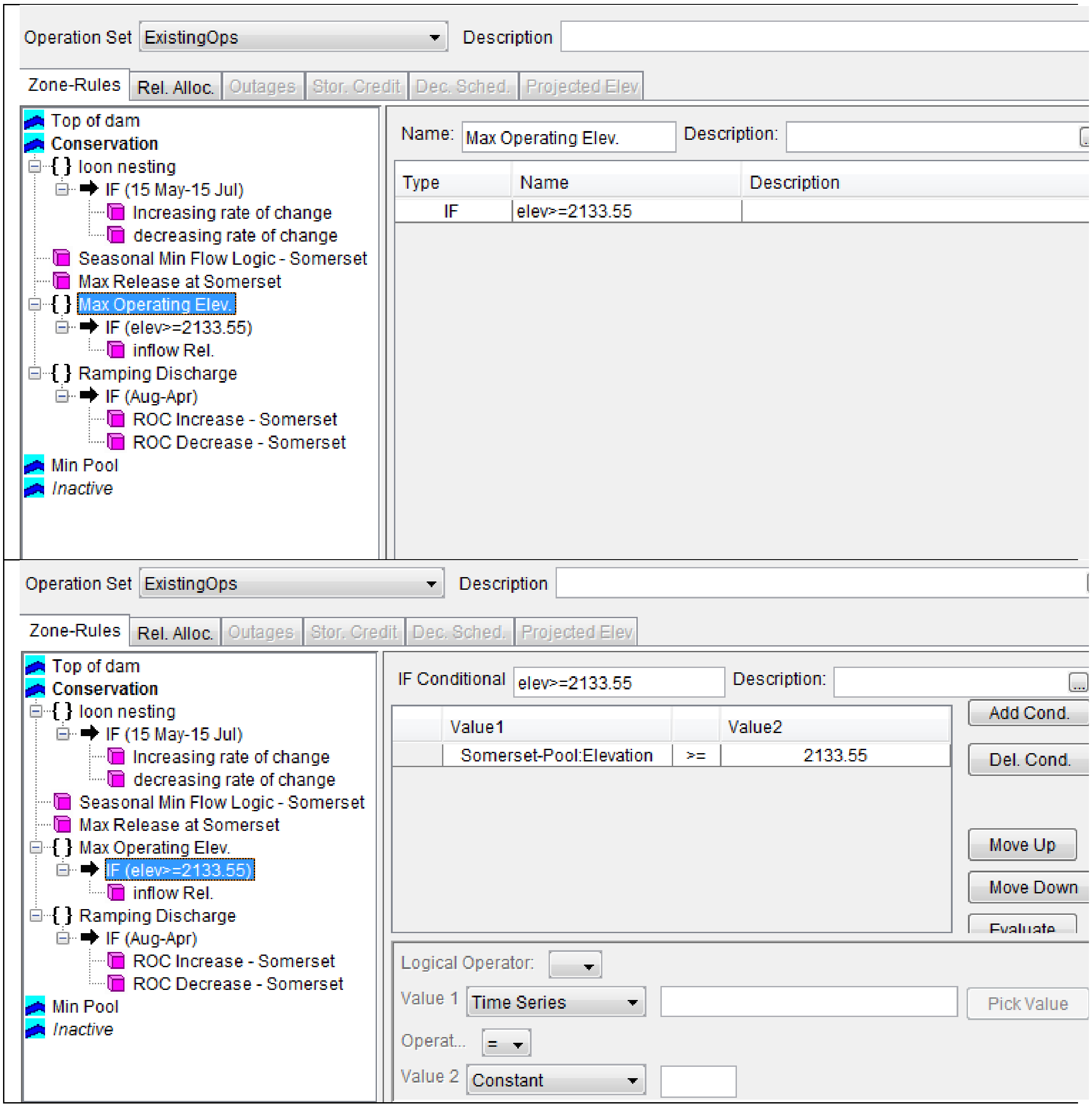


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max release at Somerset

4. *Max Operating Elev.*

Figure 11 shows the content of "Max Operating Elev" rule. This rule makes the release equal to inflow when the pool elevation is higher than 2133.55.



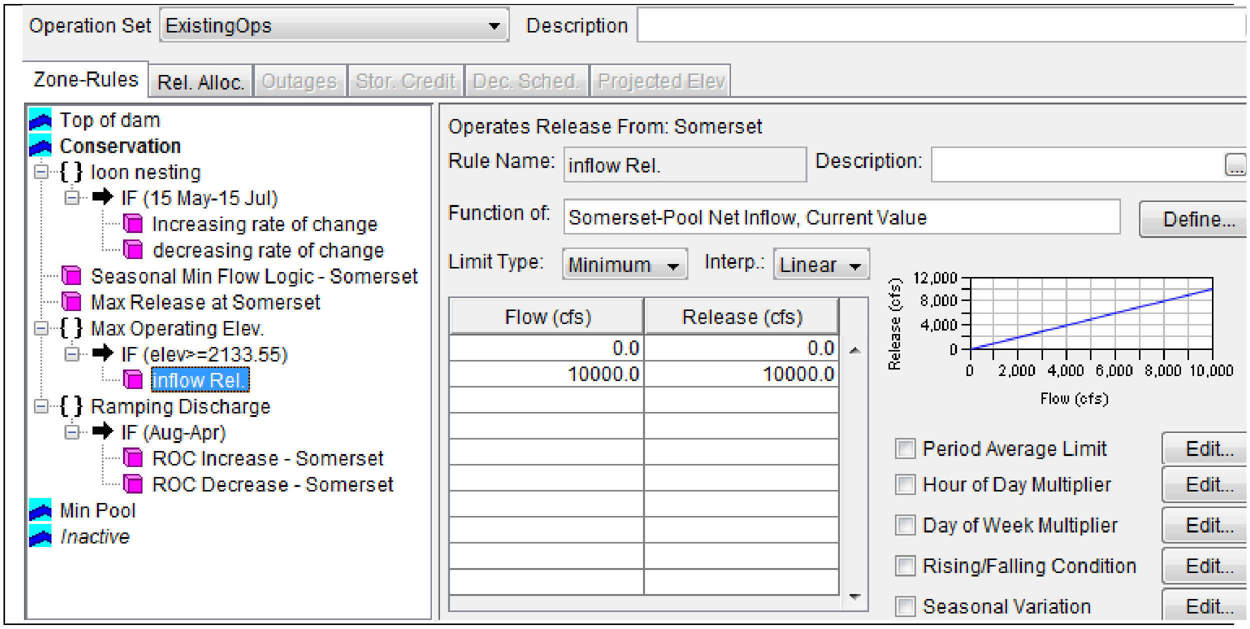
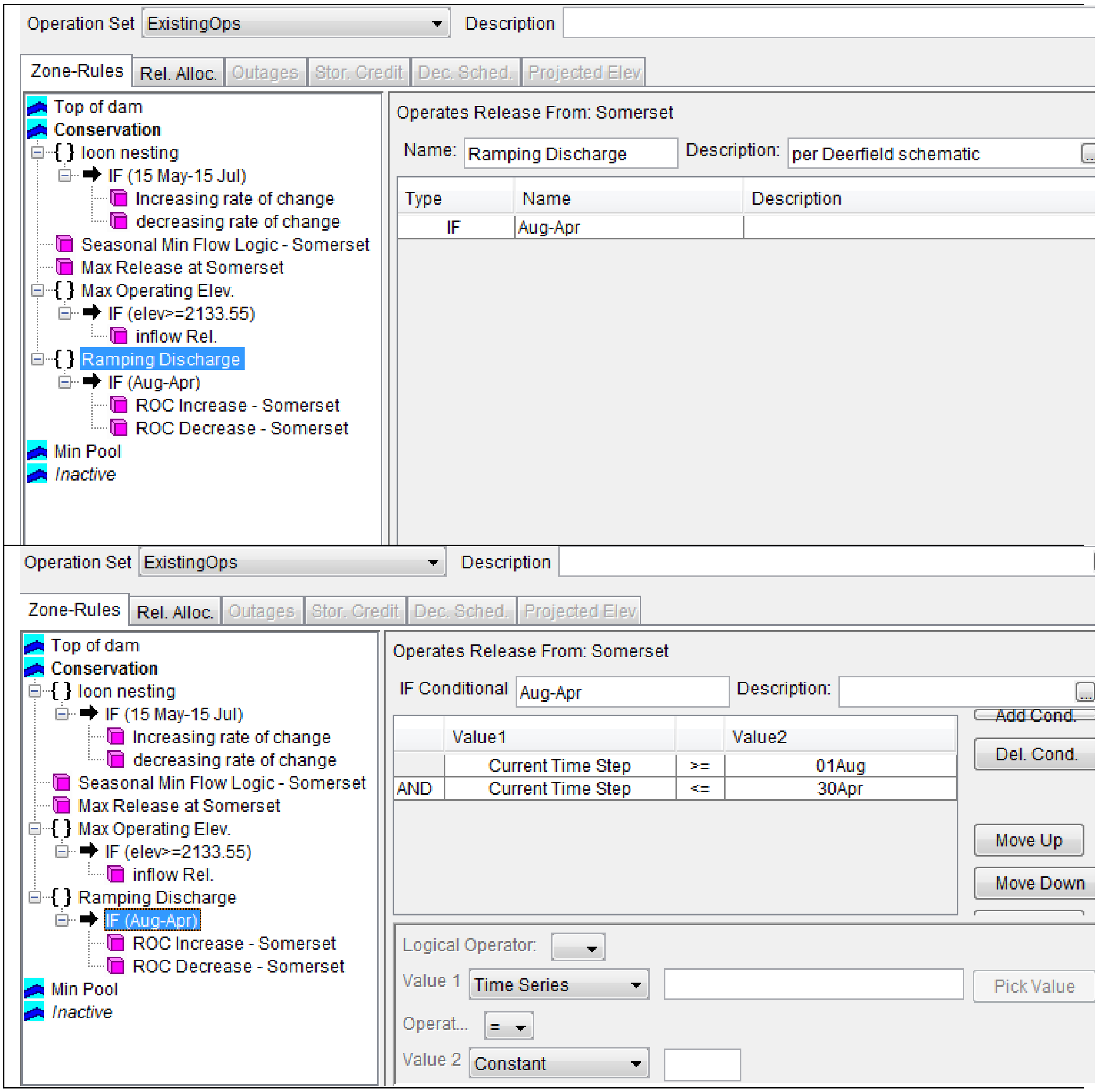


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Operating Elev.

5. *Ramping Discharge*

Figure 12 shows the content of "Ramping Discharge" rule. This rule limits the maximum increasing rate of release change to 4.1667 (cfs/hr) and the maximum decreasing rate of release change to 2.0833 (cfs/hr) during Aug-Apr.



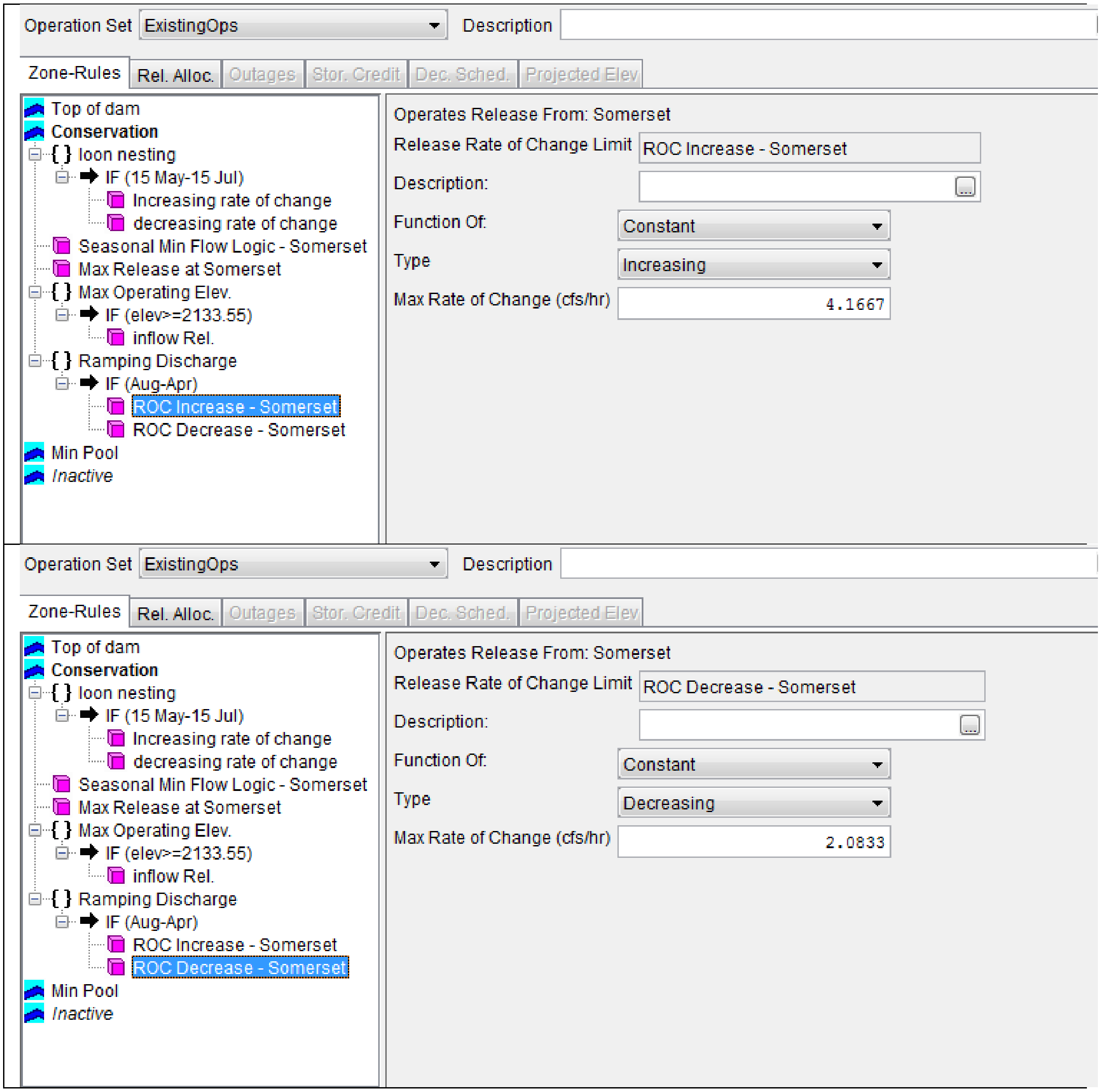


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Ramping Discharge

Sugar

I. Overview

Sugar dam is located on the Sugar River in the town of Newport, NH. It is owned and operated by Sweetwater Hydroelectric, Inc. and is used for hydropower generation.

Figure 1 shows the location of Sugar dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Sugar dam.

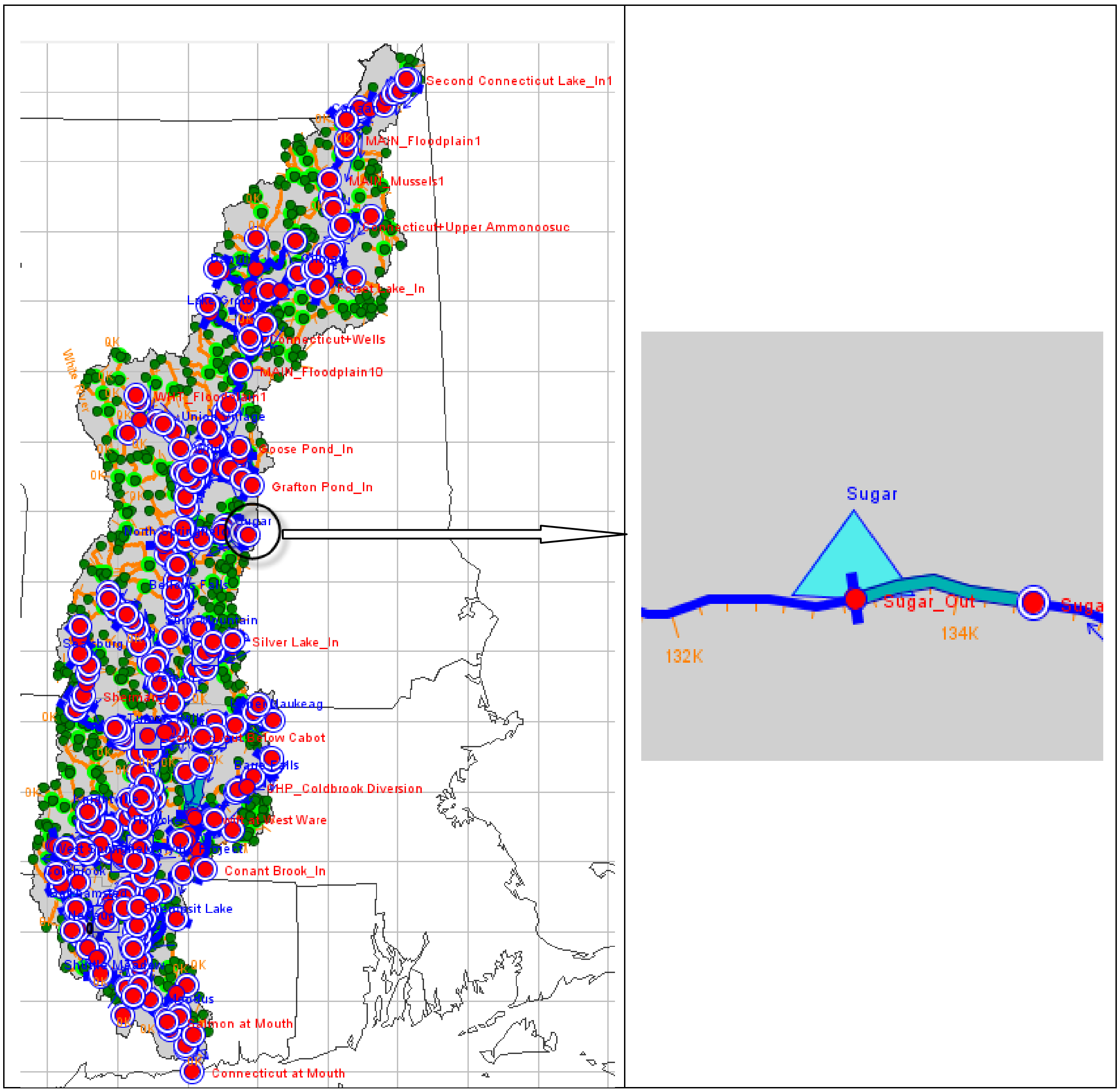


Figure 1: HEC-ResSim Map Display Showing Location of Sugar Dam

Figure 2: Photo of Sugar dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[94]. The dam consists of three types of outlets: (1) controlled Waste Sluice, (2) uncontrolled outlet, and (3) controlled Inlet pipe for pump power generation as shown in Figure 4.

[94] NHDams Data Sheet. Sugar River Mill Dam. 2010.

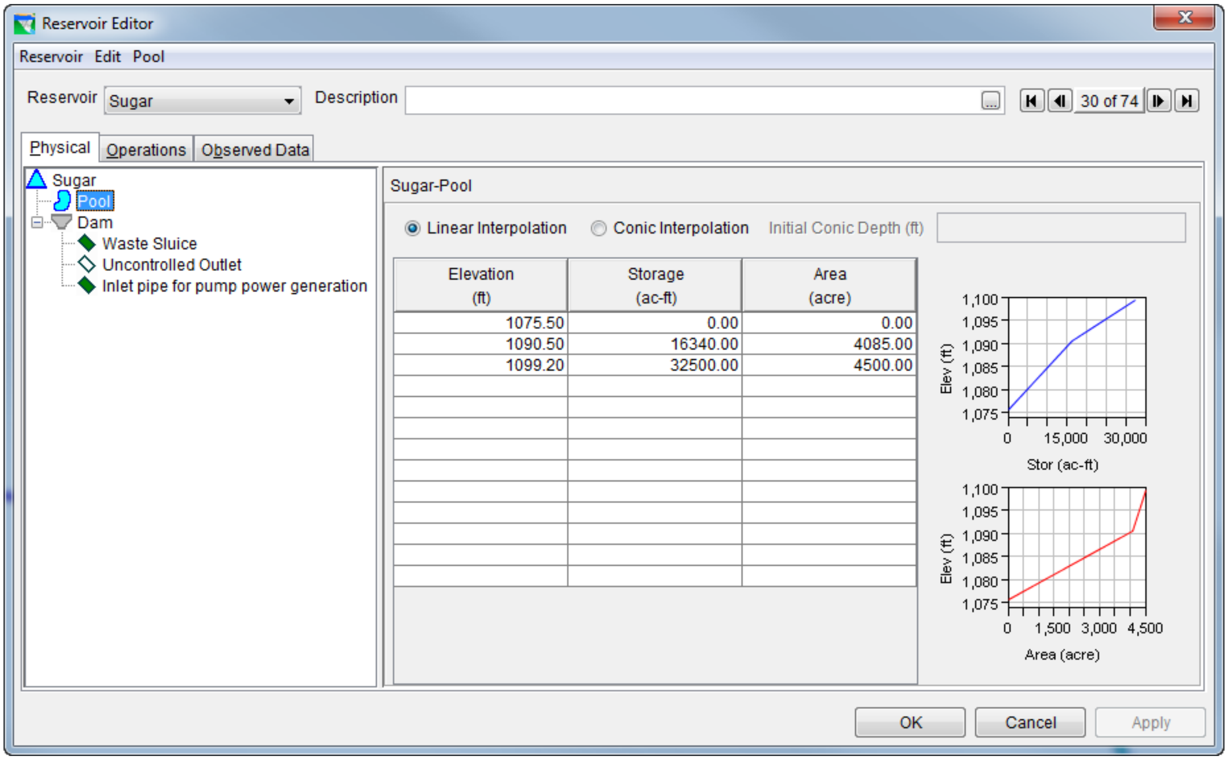


Figure 3: Reservoir Editor: Physical Tab -- Pool

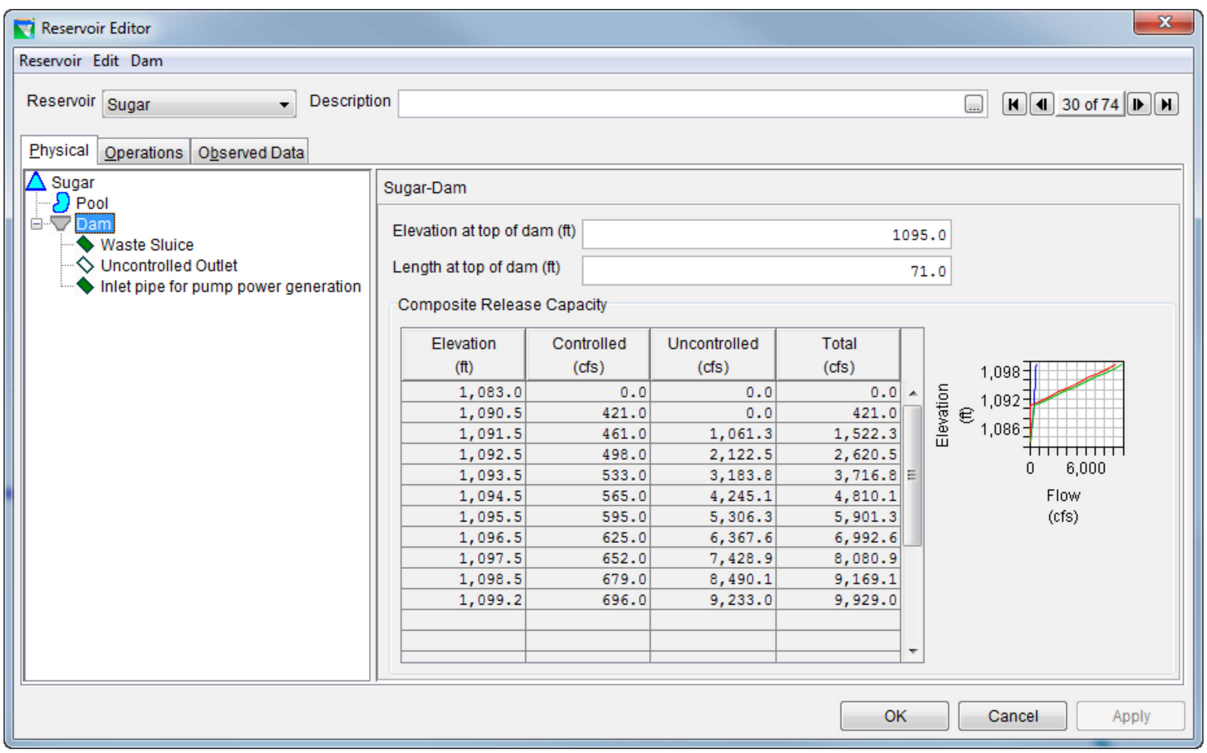


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Sugar's "Guide Curve" operational zones, which consist of zones of Flood Control (1094.5 ft), Conservation (1090.5 ft), and Inactive zone (1076 ft).

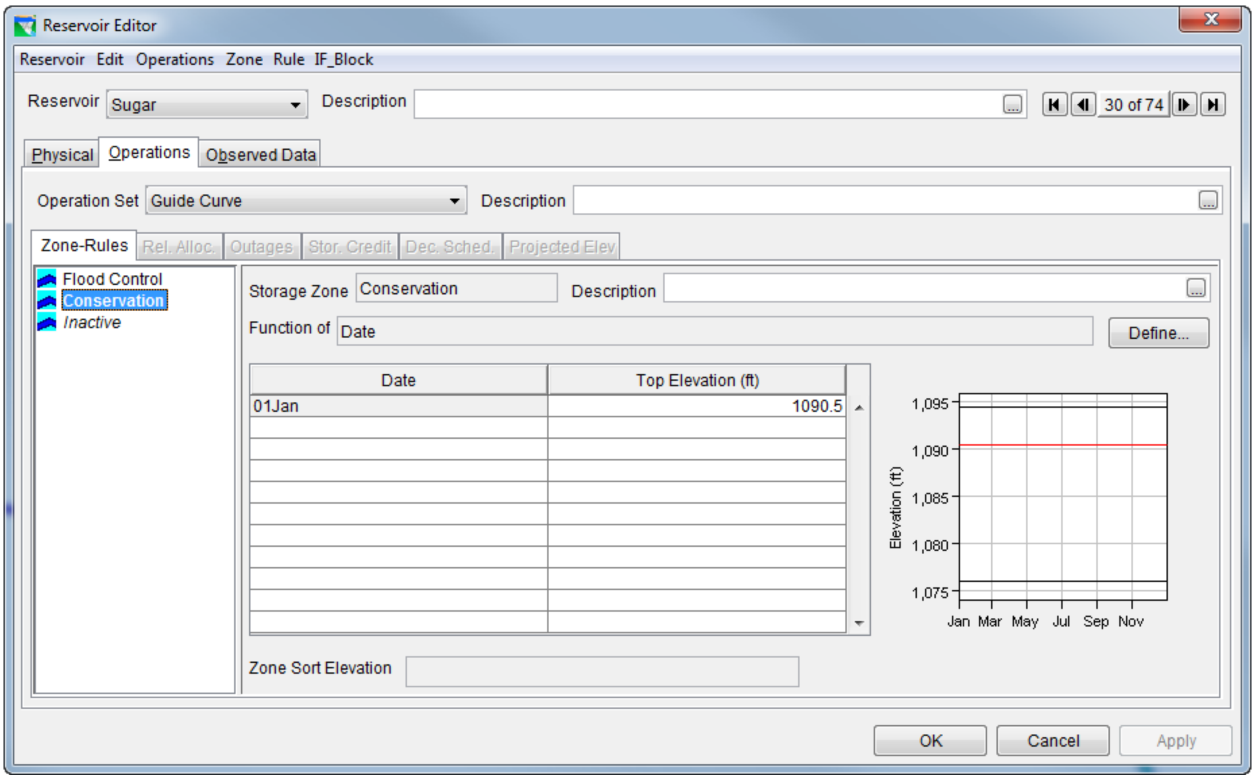


Figure 5: Reservoir Editor: Operations Tab –Guide Curve OpSet – Guide Curve

B. Rule Illustrations

The operation set for Sugar has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Surry Mountain

I. Overview

Surry Mountain Dam is a dam upstream of Keene, New Hampshire on the Ashuelot River. It was constructed by the US Army Corps of Engineers in 1941 and is still owned and operated by the Corps. It is primarily used for flood control purposes but also for recreation.

Figure 1 shows the location of Surry Mountain Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of the dam.

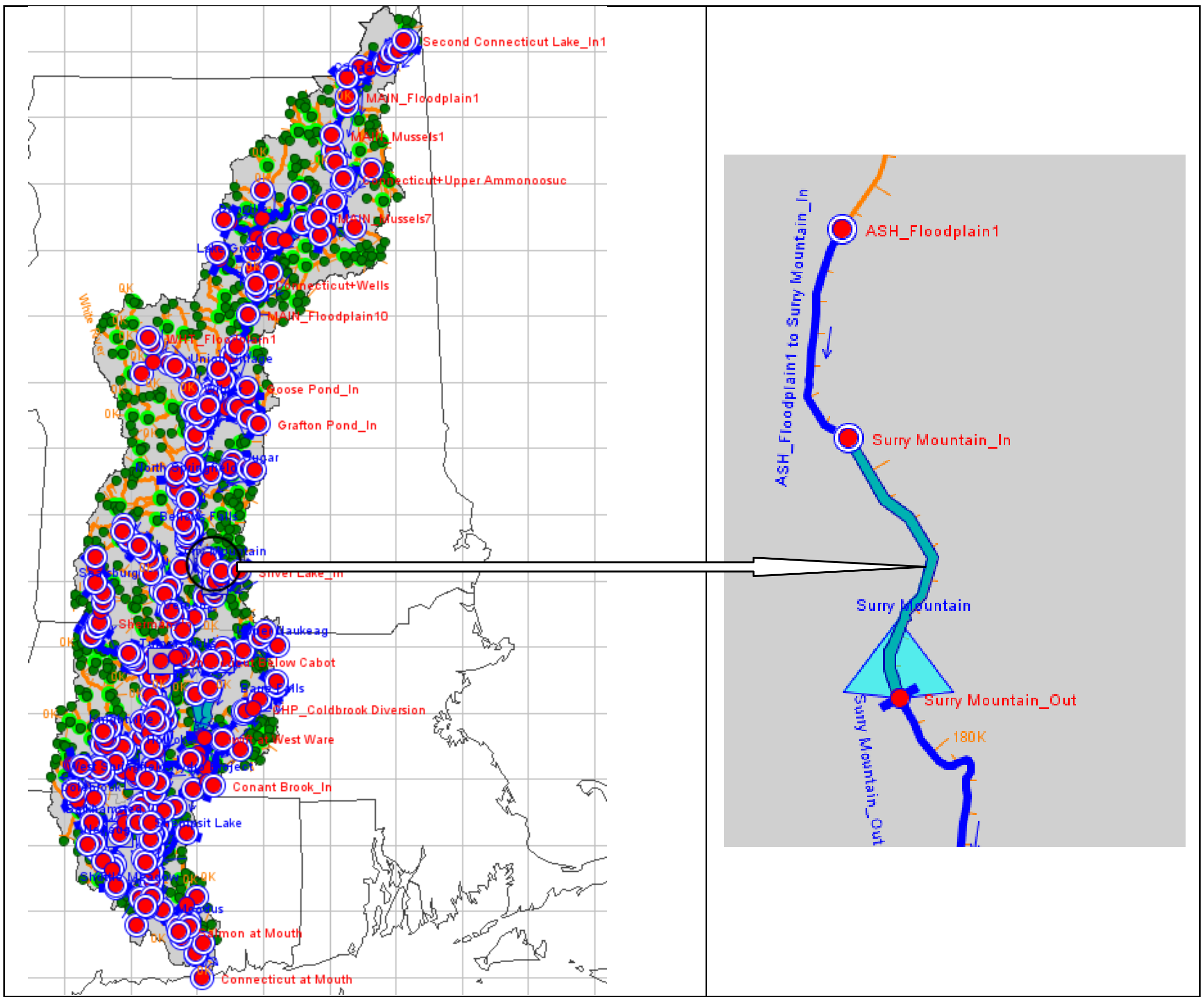


Figure 1: HEC-ResSim Map Display Showing Location of Surry Mountain dam

Figure 2: Photo of Surry Mountain Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled Broome gates, and (2) uncontrolled spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[95].

[95] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

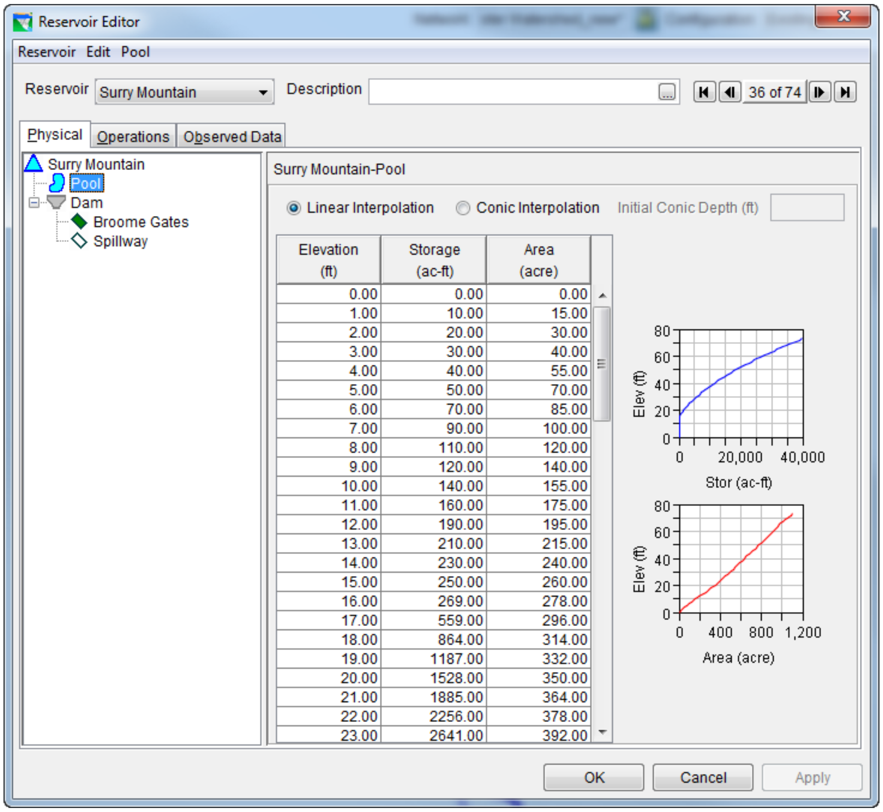


Figure 3: Reservoir Editor: Physical Tab -- Pool

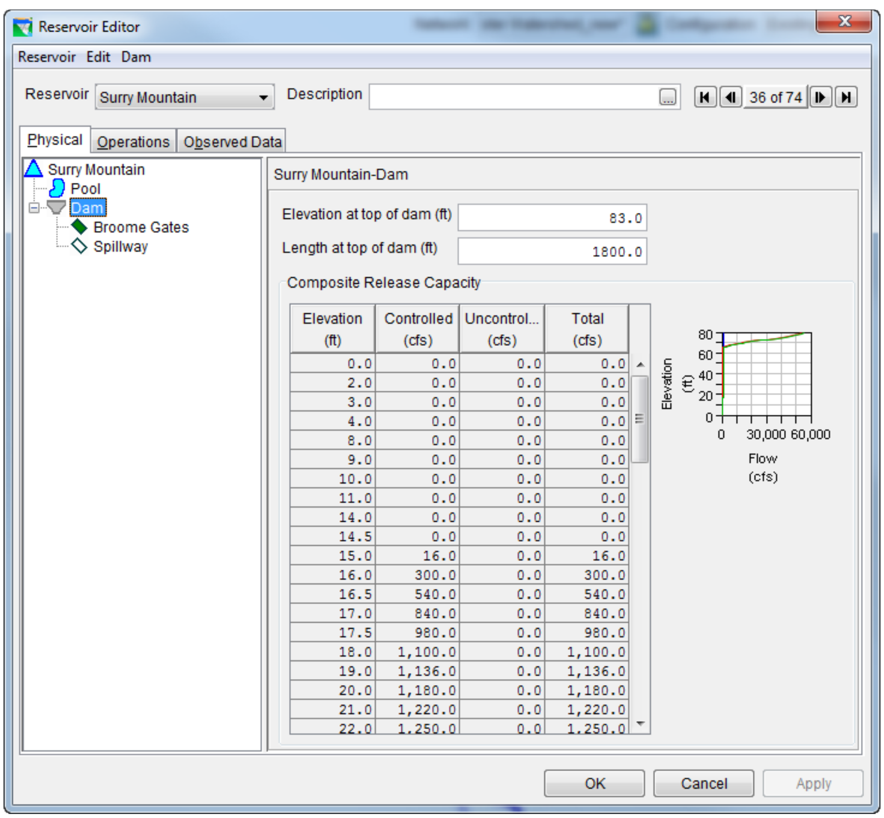


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Surry Mountain's "ExistingOps" operational zones, which consist of zones of Surcharge-near TOD (83 ft), Surcharge (75 ft), Flood Control (65 ft), Conservation (15-18 ft), and Inactive zone (0 ft).

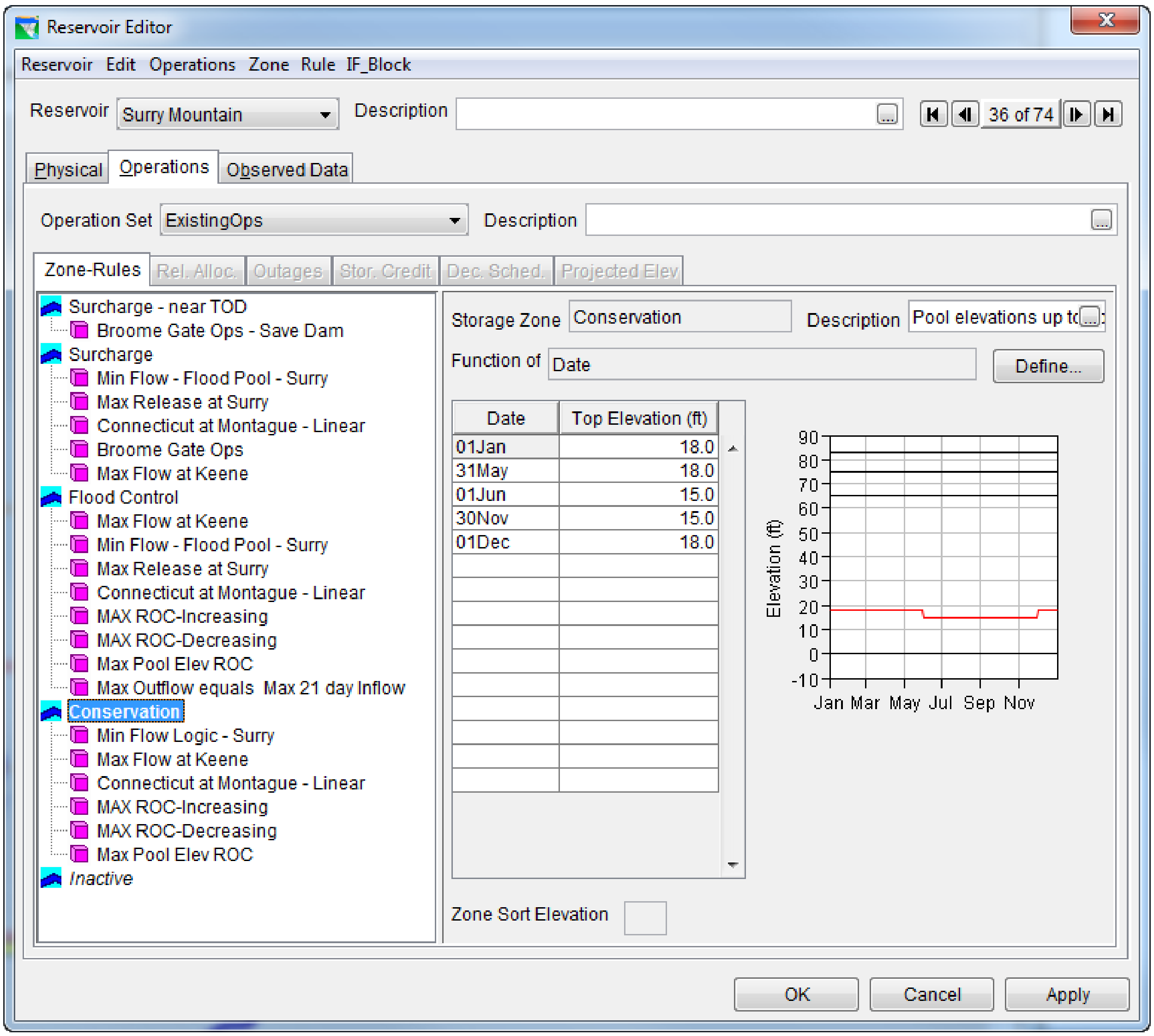


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

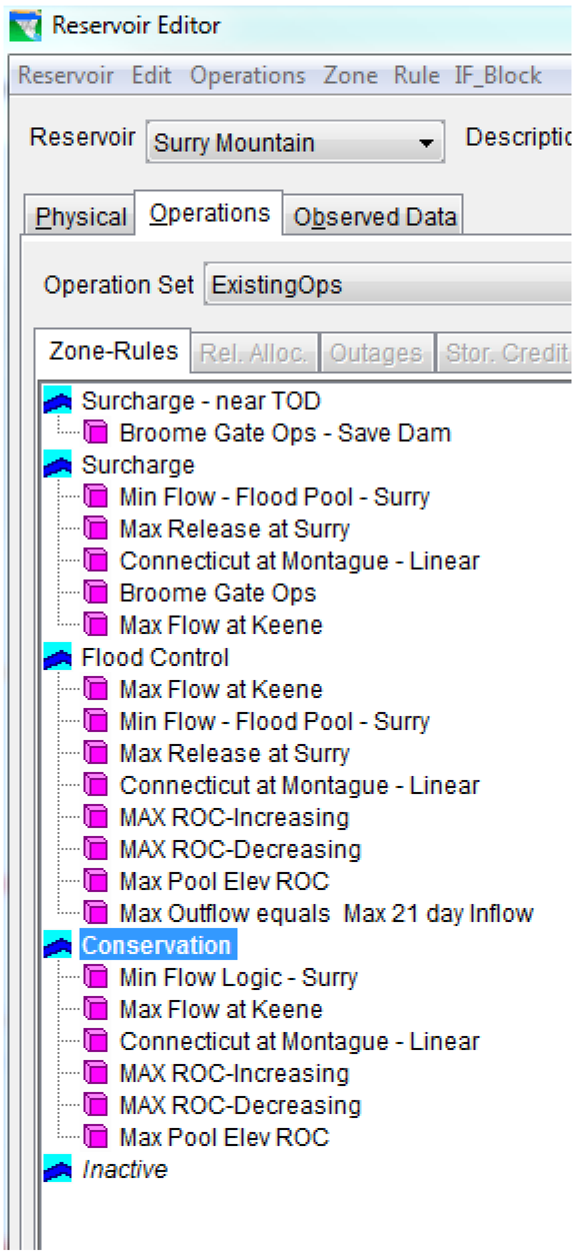


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Broome Gate Ops-Save Dam

Figure 7 shows the content of “Broome Gate Ops-Save Dam” rule. This rule represents the maximum allowable release from Slide gates as a function of pool elevation when the pool is in Surcharge-near TOD zone.

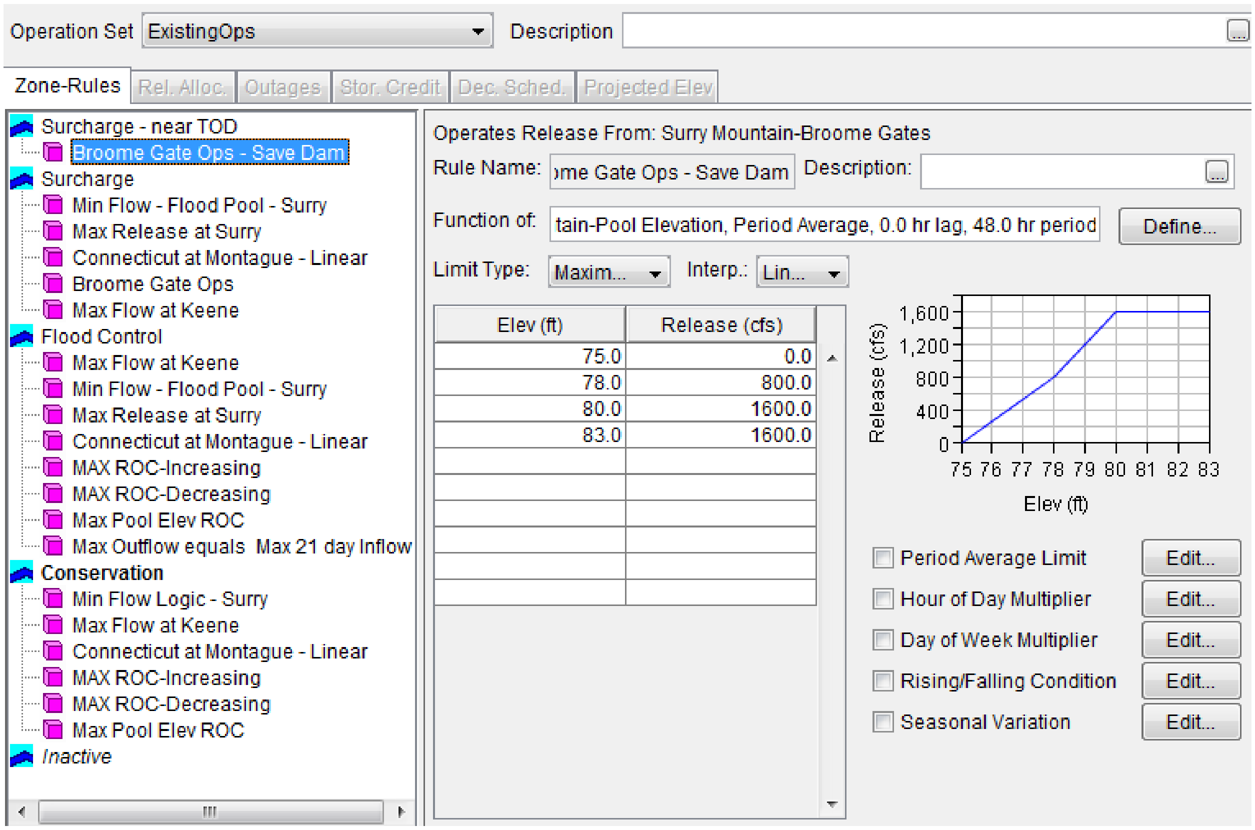


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Broome Gate Ops-Save Dam

2. Min Flow-Flood Pool-Surry

Figure 8 shows the content of "Min flow-Flood Pool-Surry" rule. This rule shows the required minimum release from dam during flood control operations.

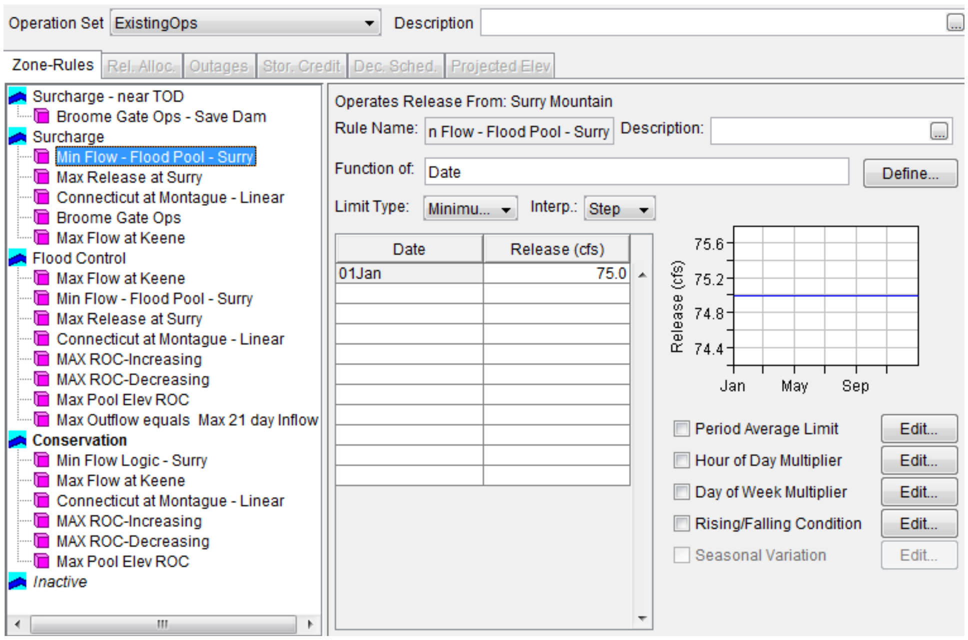


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow-Flood pool-Sury

3. Max Release at Surry

Figure 9 shows the content of "Max release at Surry" rule. This rule shows a seasonal maximum allowable release from dam.

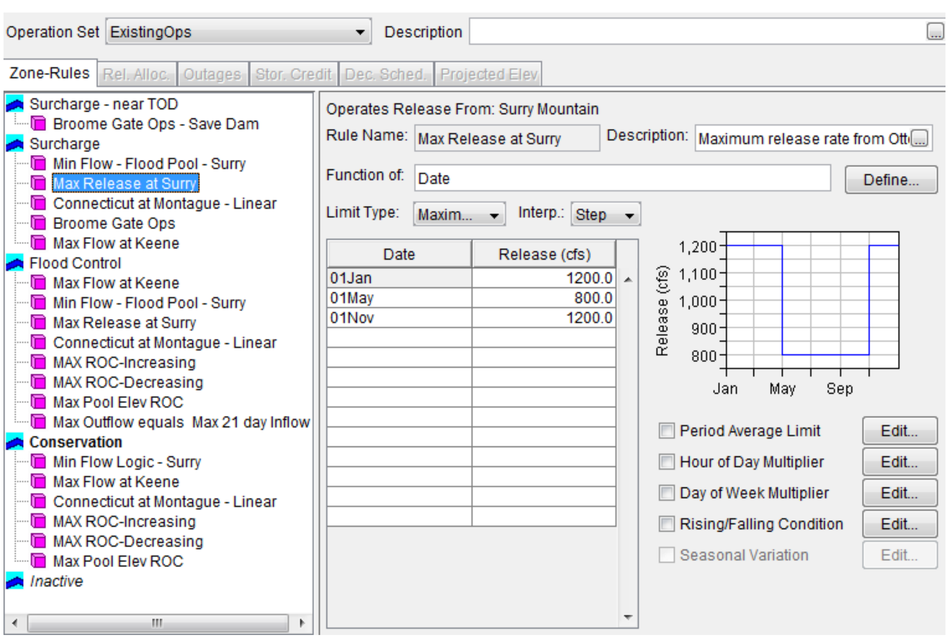


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Release at Surry

4. Connecticut at Montague-Linear

Figure 10 shows the content of "Connecticut at Montague-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montague. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

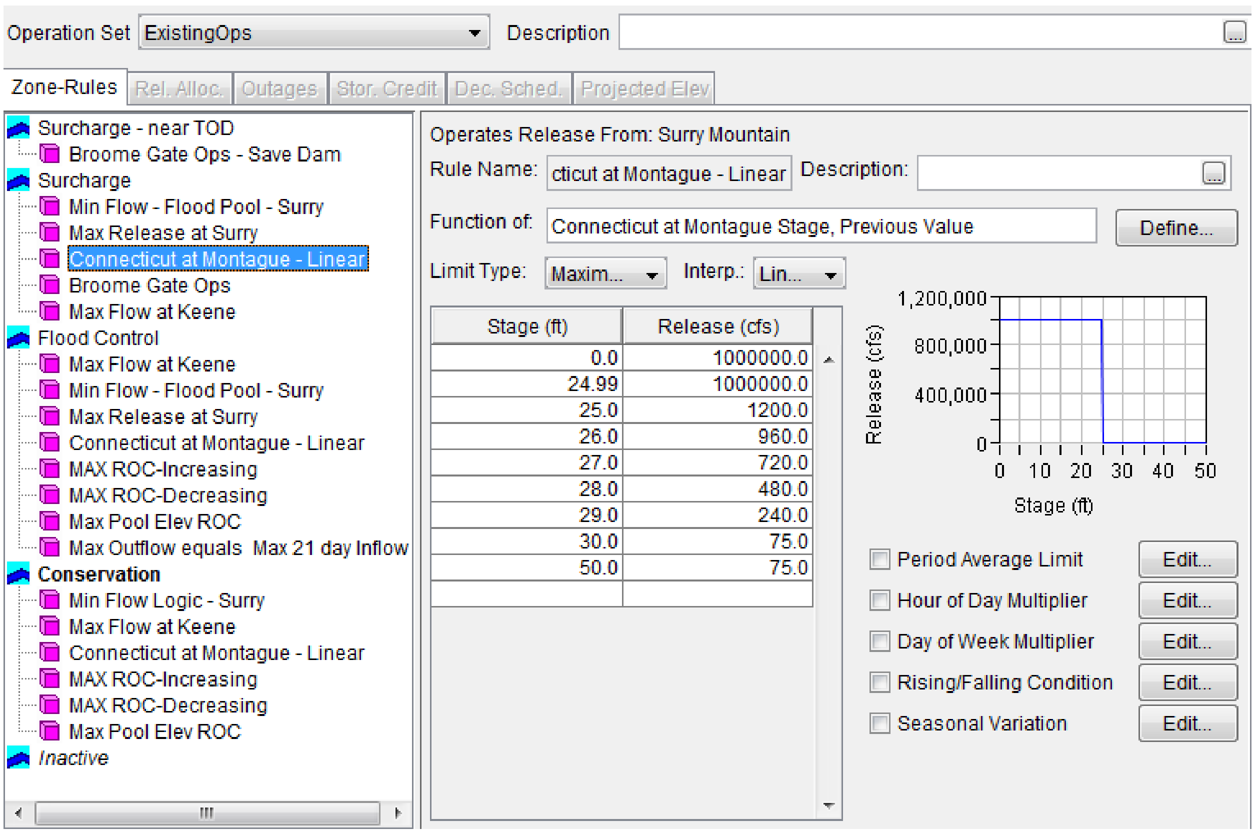


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague-Linear

5. Broome Gate Ops

Figure 11 shows the content of "Broome Gate Ops" rule. This rule shows a seasonal maximum release from Broome gates as a function of pool elevation when the pool is in Surcharge zone.

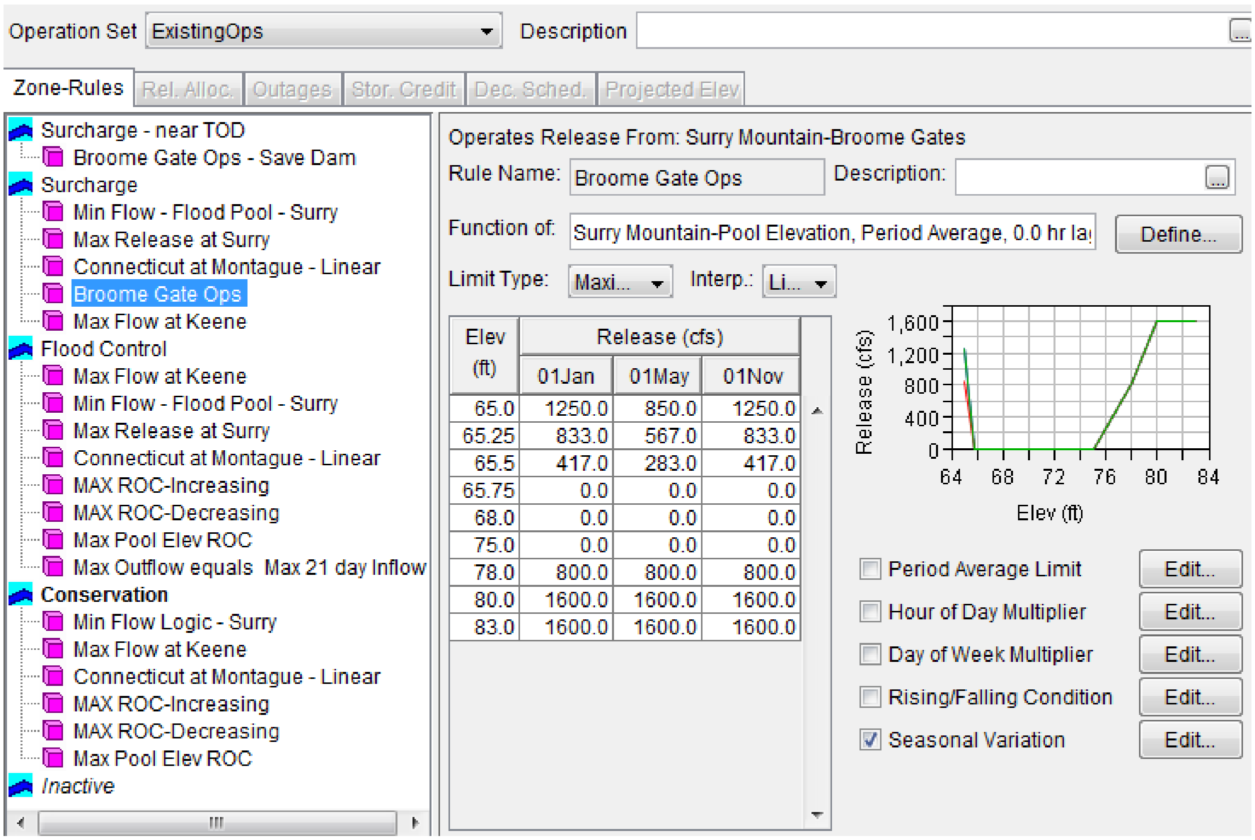


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Broome Gate Ops

6. *Max Flow at Keene*

Figure 12 shows the content of "Max Flow at Keene" rule. This rule represents the maximum allowable flow downstream at the point Ashuelot+Otter Brook.

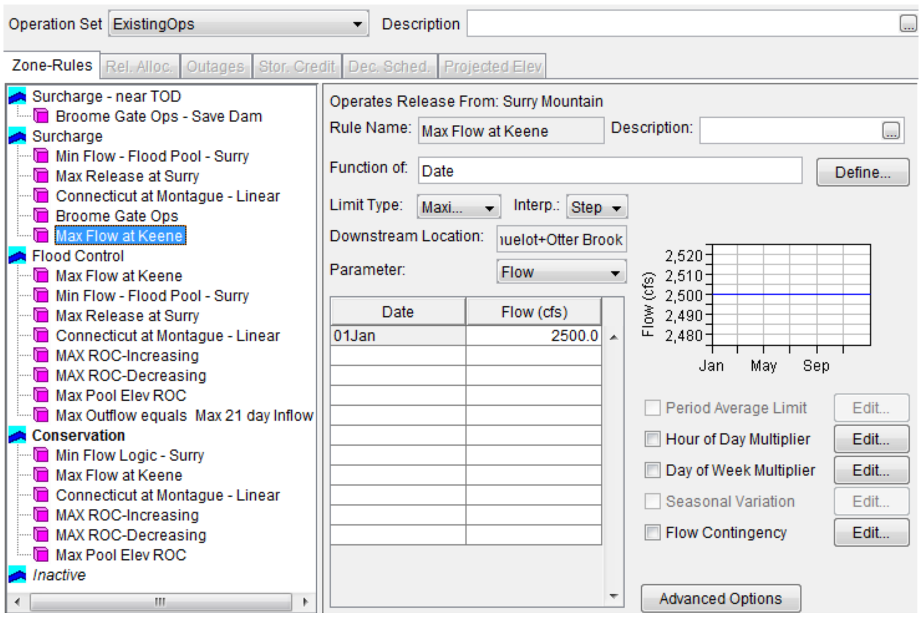


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Flow at Keene

7. *Max ROC-Increasing*

Figure 13 shows the content of "Max ROC-Increasing" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Surry Mountain dam.

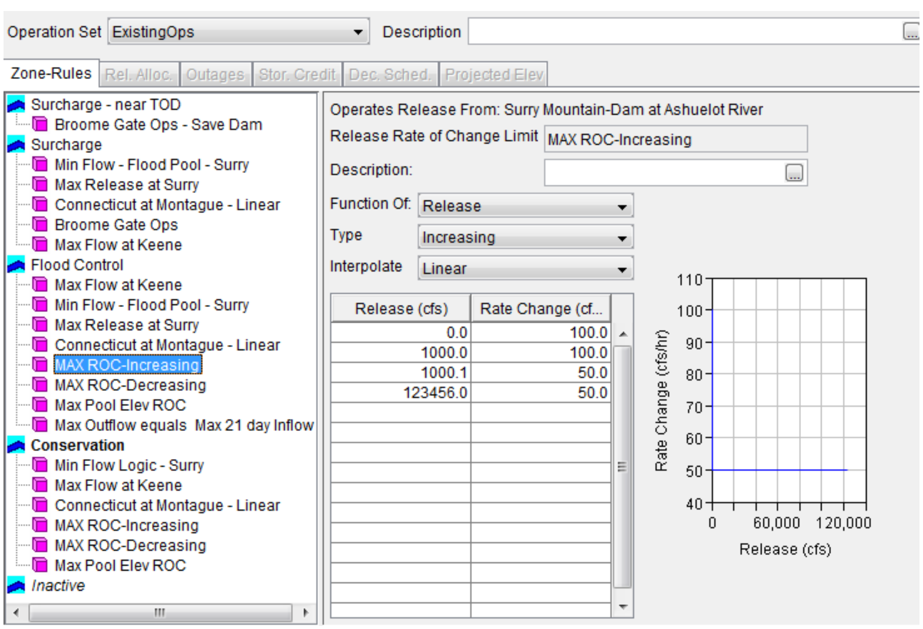


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max ROC-Increasing

8. Max ROC-decreasing

Figure 14 shows the content of “Max ROC-Decreasing” rule. This rule shows the maximum allowable decreasing release rate of change as a function of release from Surry Mountain dam.

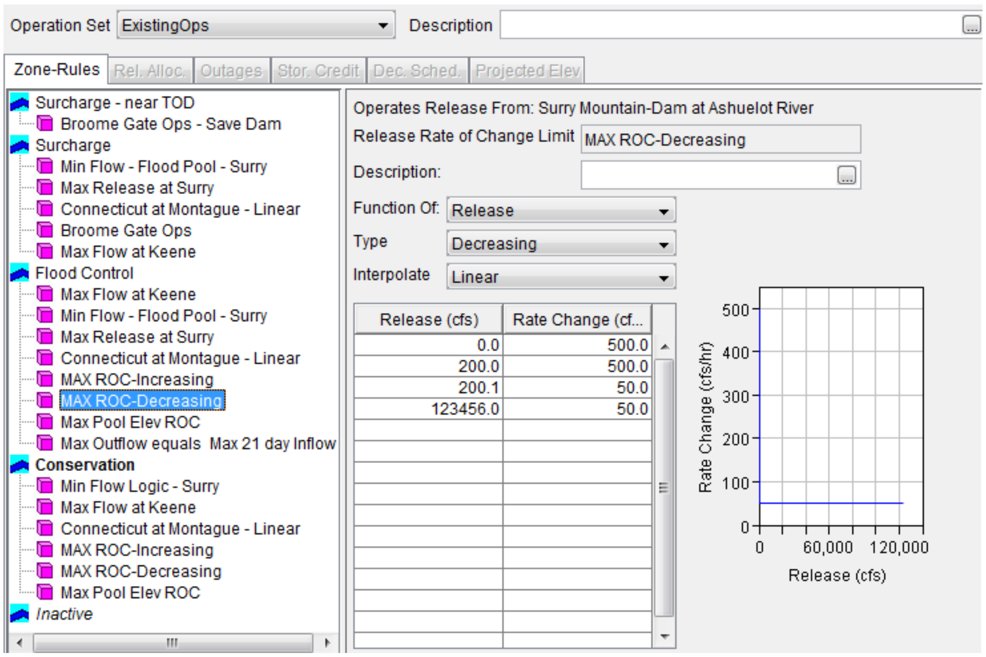


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max ROC-Decreasing

9. Max Pool Elev ROC

Figure 15 shows the content of “Max pool Elev ROC” rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

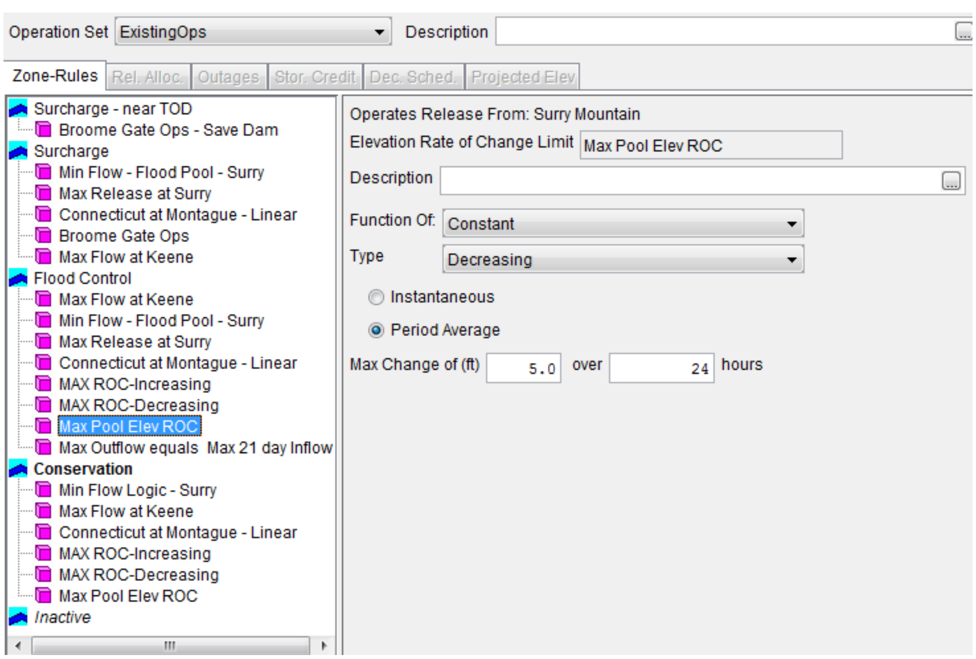


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Pool Elev ROC

10. Max Outflow equals Max 21 day Inflow

Figure 16 shows the content of "Max Outflow equals Max 21 day Inflow" rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

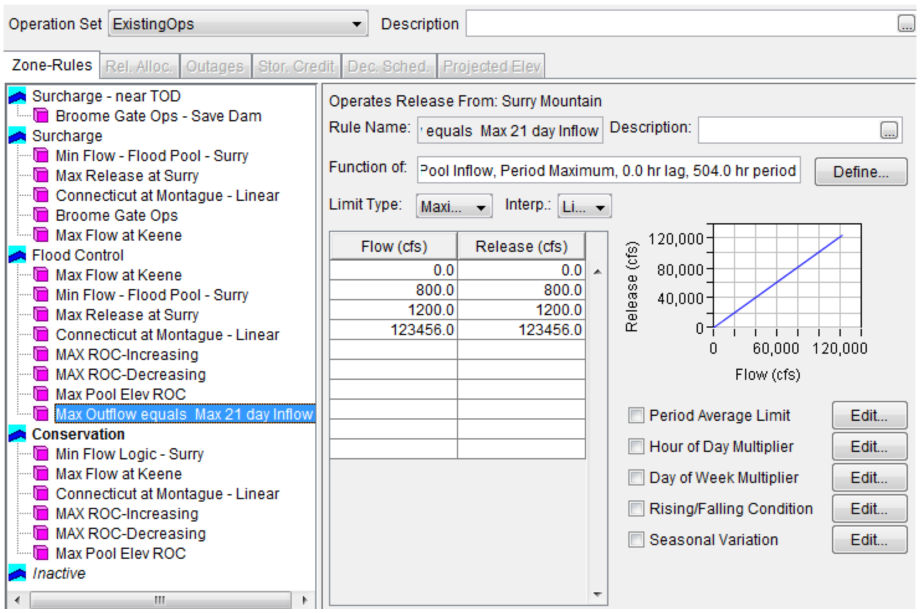


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals Max 21 day Inflow

11. Min Flow Logic-Surry

Figure 17 shows the content of "Min flow Logic-Surry" rule. This rule provides seasonal minimum releases from Surry Mountain as a function of inflow.

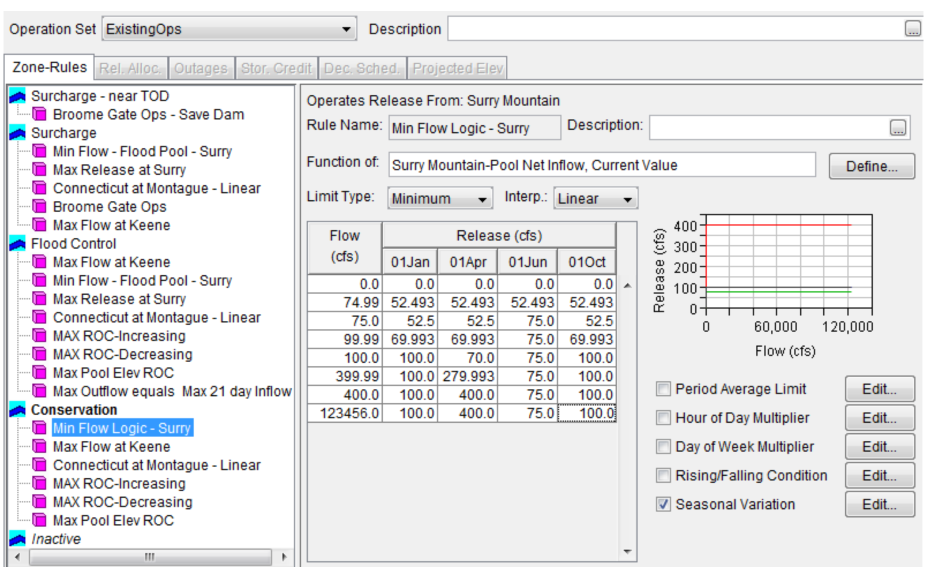


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic -Surry

Tighe Carmody

I. Overview

Tighe Carmody dam is located in the town of Southampton, MA on the Manhan River. It is owned and operated by Holyoke Water Works and is used for water supply for the City of Holyoke.

Figure 1 shows the location of Tighe Carmody Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Tighe Carmody dam.

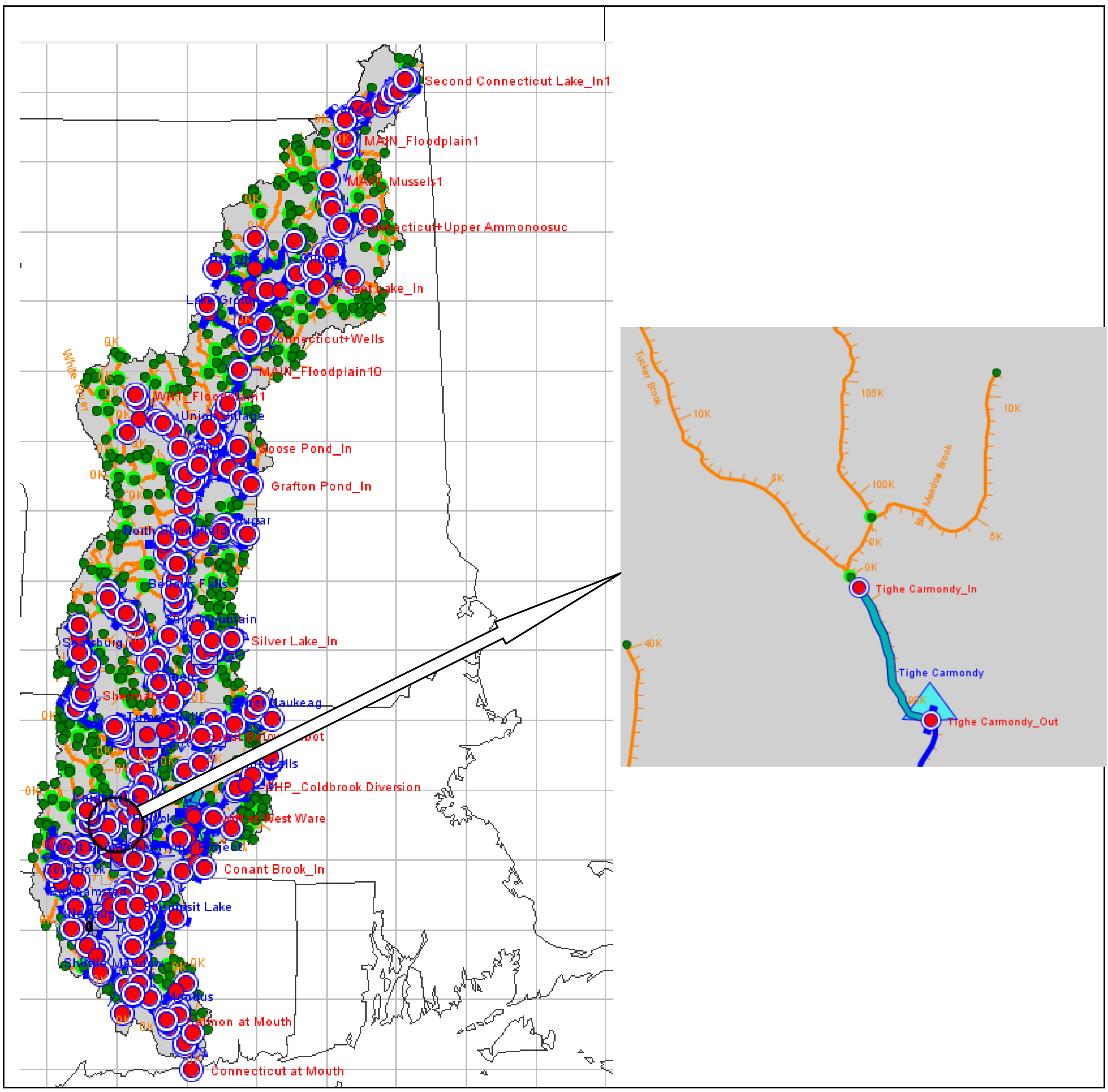


Figure 1: HEC-ResSim Map Display Showing Location of Tighe Carmody

Figure 2: HEC-ResSim Photo of Tighe Carmody Dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[96]. The dam consists of two types of outlets: (1) uncontrolled spillway, and (2) controlled Draw-down Conduit as shown in Figure 4.

[96] Phase I Report. 1978

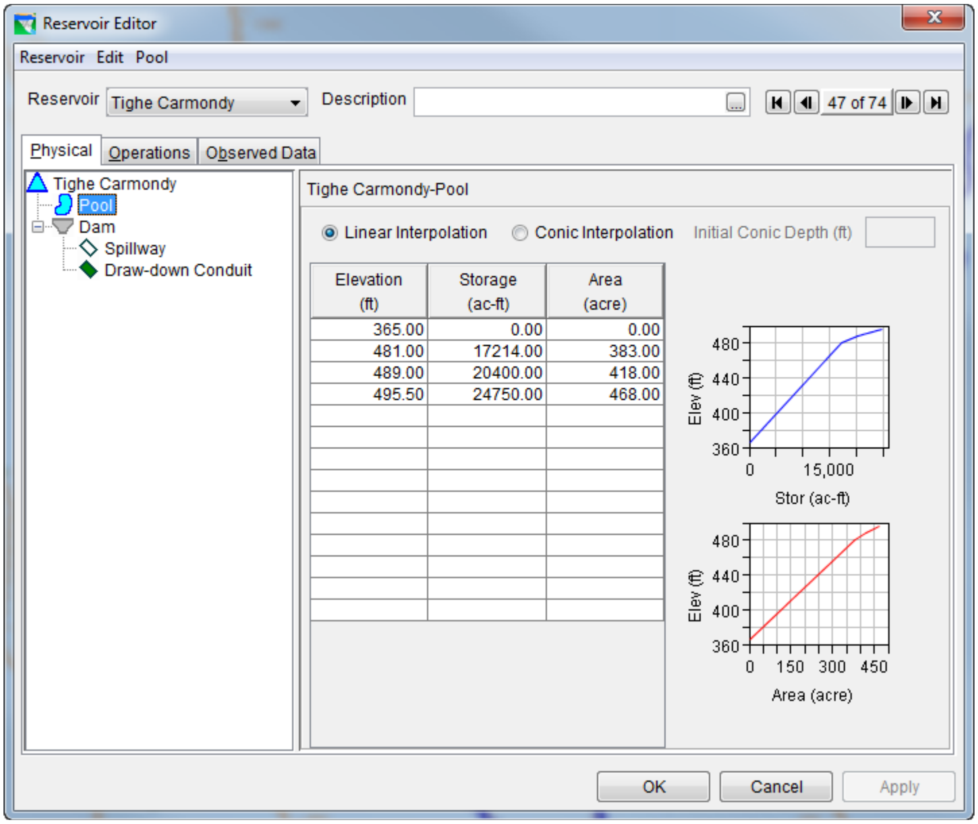


Figure 3: Reservoir Editor: Physical Tab -- Pool

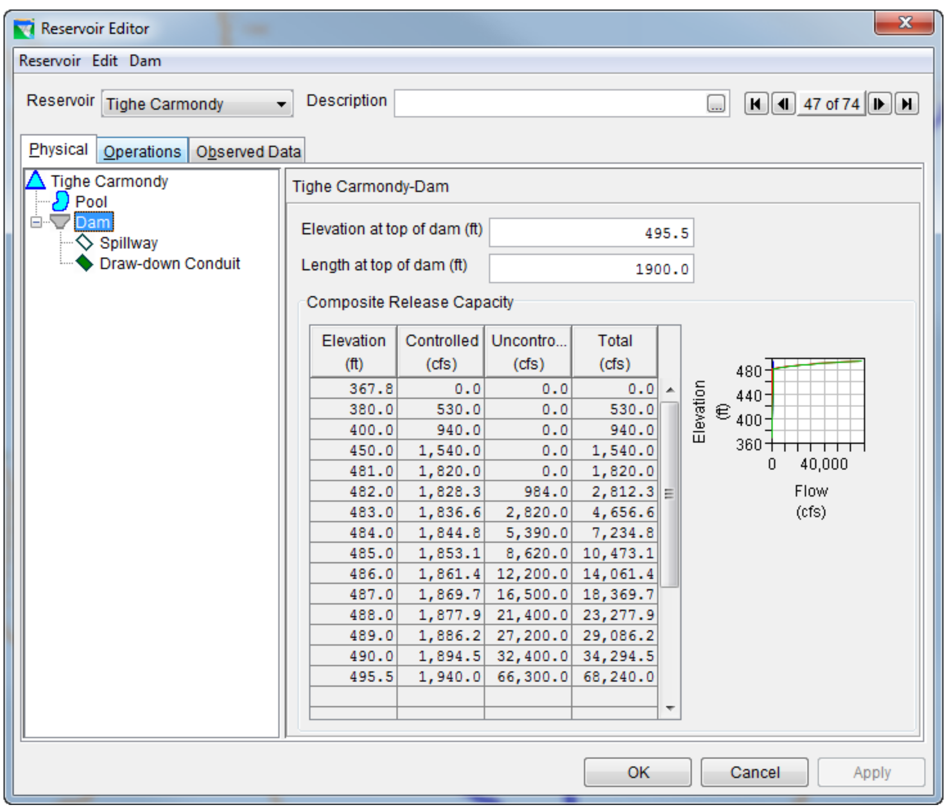


Figure 3 Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Tighe Carmody's "Existing Ops" operational zones, which consist of zones of Flood Control (495.5 ft), conservation (481 ft), and Inactive zone (365 ft)[1].

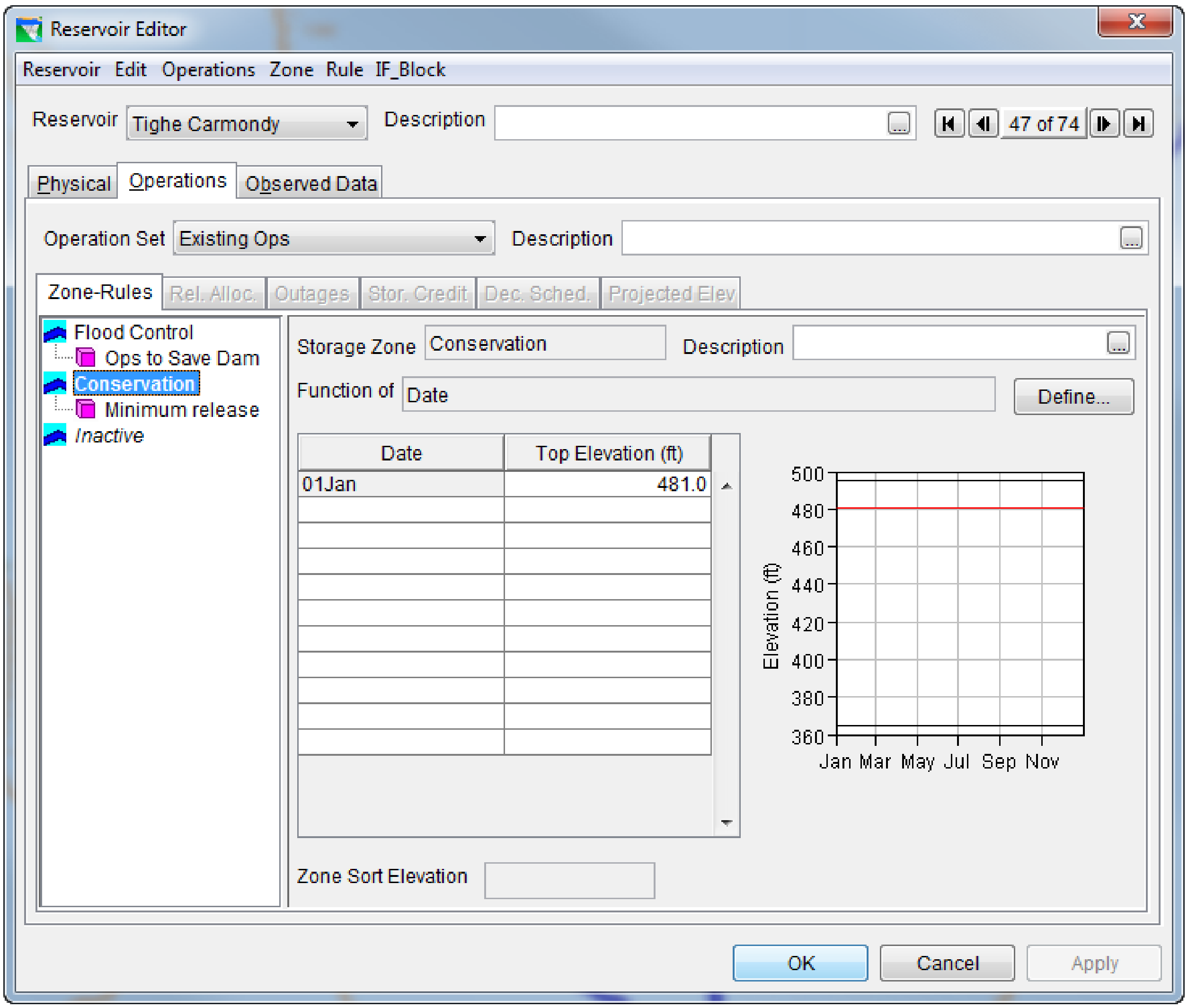


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 5 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. There is a water supply time series associated with Tighe Carmondy which is described in the water supply section of the report.

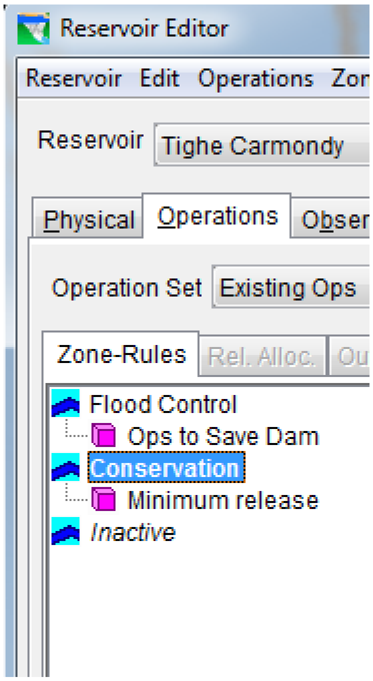


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Ops to save Dam

Figure 7 shows the content of "Ops to save Dam" rule. This rule shows when the pool elevation gets to elevation 487 ft the maximum release of 1940 will occur to save the dam.

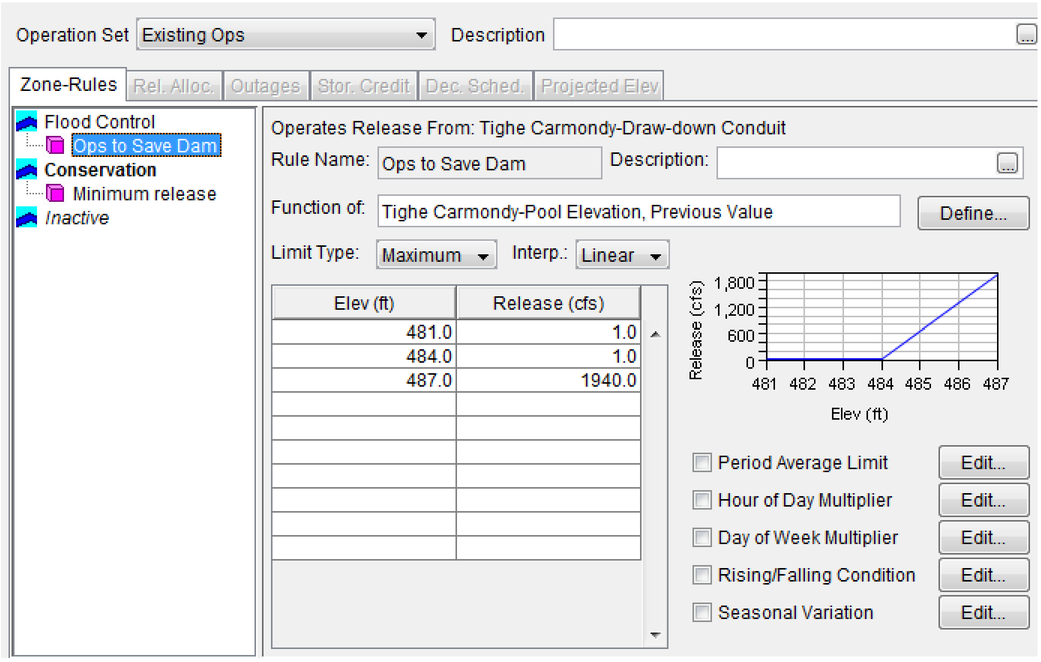


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Ops to save Dam

2. *Minimum Release*

Figure 8 shows the content of "Minimum Release" rule. This rule represents a minimum release of 1 cfs from Tighe Carmody reservoir.

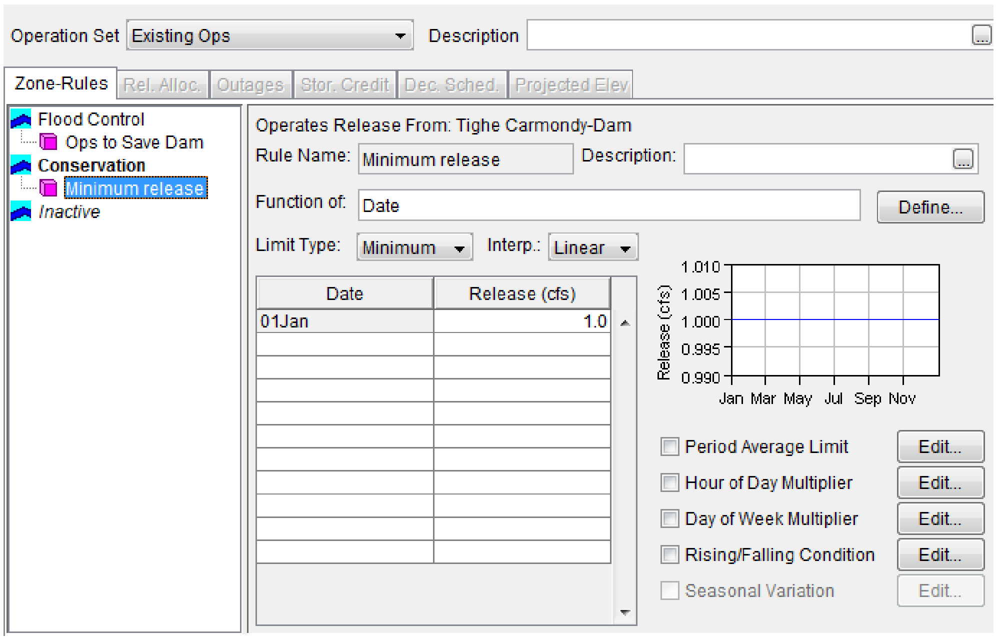


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Minimum Release

Townshend

I. Overview

Townshend dam is a dam located in Townshend, Vermont on the West River. It was constructed in 1961 by the US Army Corps of Engineers and is still owned and operated by the Corps. It is primarily used for flood control purposes but also for recreation.

Figure 1 shows the location of Townshend Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from Townshend Dam.

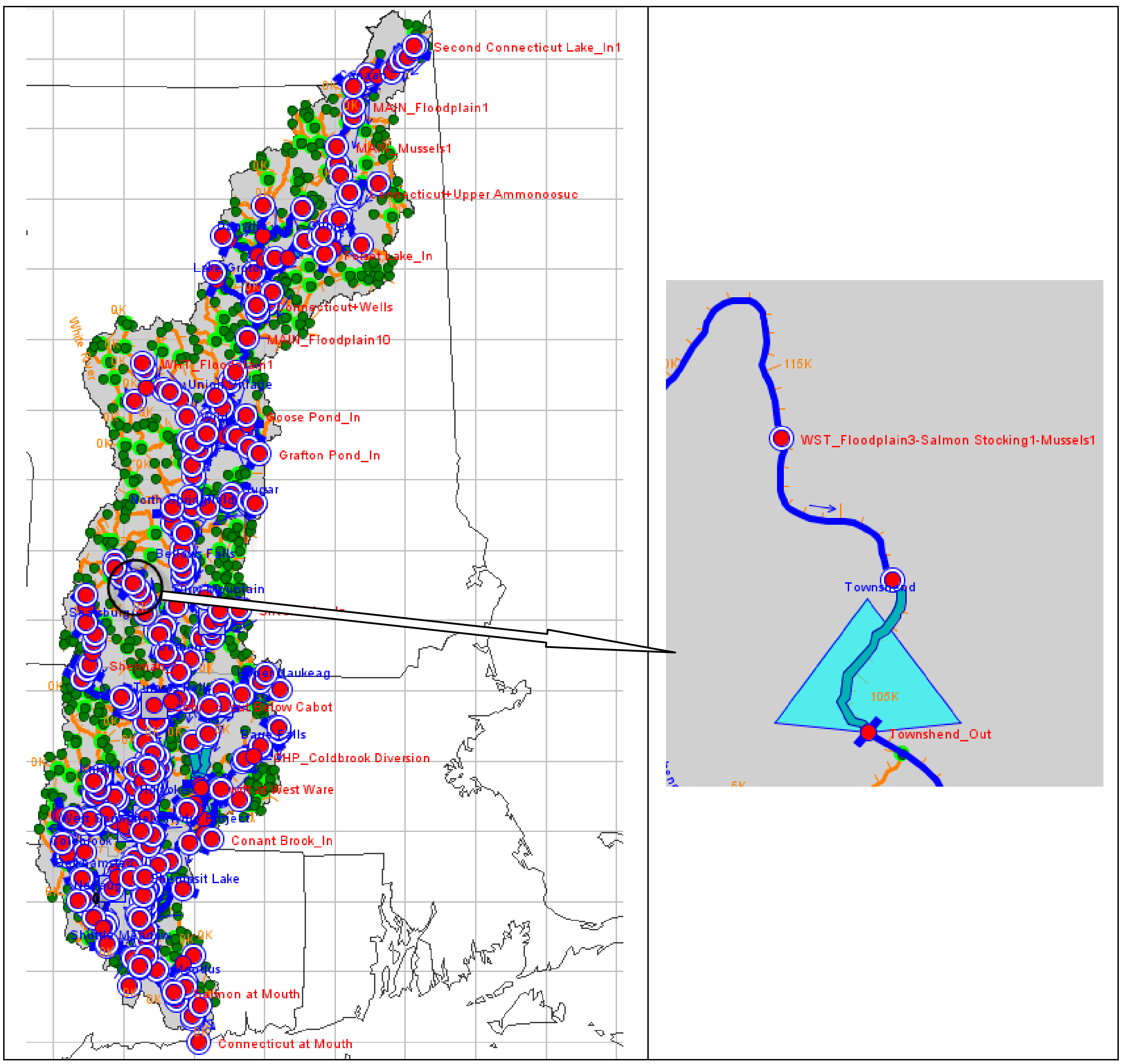


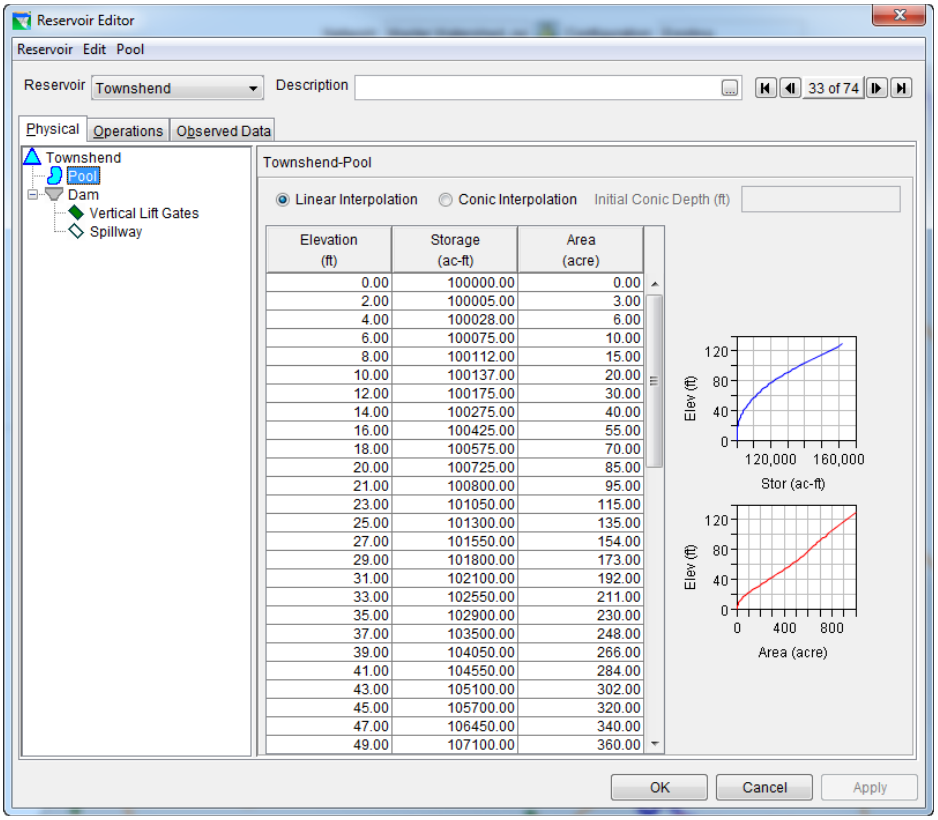
Figure 1 HEC-ResSim Map Display Showing Location of Townshend dam

Figure 2: Photo of Townshend dam

II. Physical Characteristics

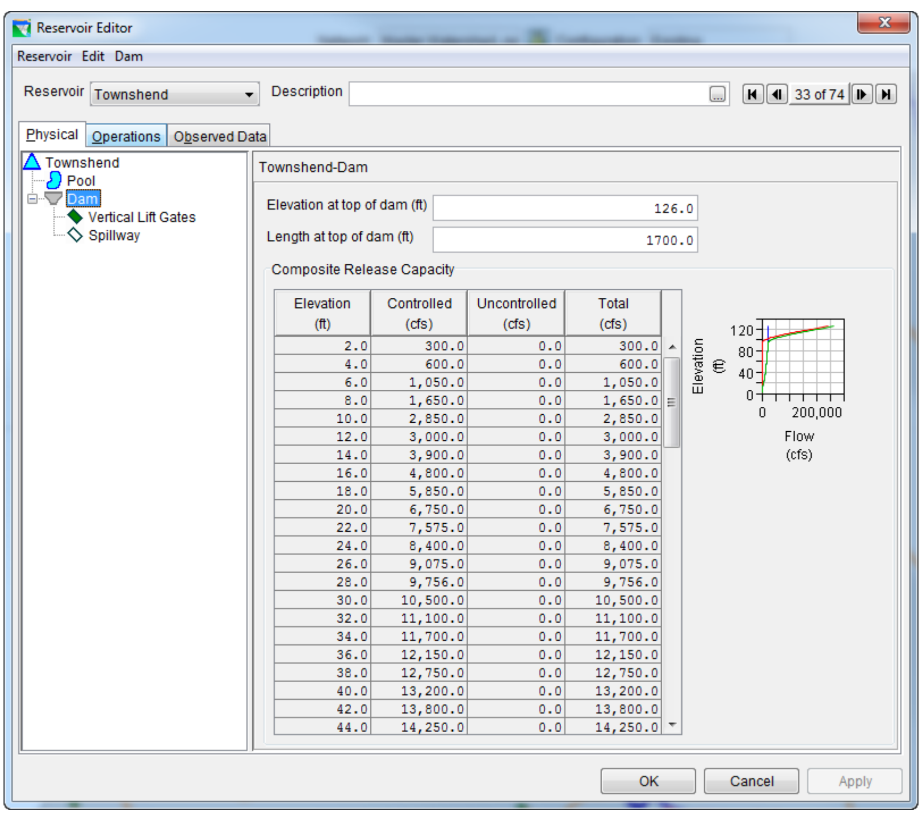
The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled vertical lift gates, and (2) uncontrolled spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[97].

[97] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index



Elevation (ft)	Storage (ac-ft)	Area (acre)
0.00	100000.00	0.00
2.00	100005.00	3.00
4.00	100028.00	6.00
6.00	100075.00	10.00
8.00	100112.00	15.00
10.00	100137.00	20.00
12.00	100175.00	30.00
14.00	100275.00	40.00
16.00	100425.00	55.00
18.00	100575.00	70.00
20.00	100725.00	85.00
21.00	100800.00	95.00
23.00	101050.00	115.00
25.00	101300.00	135.00
27.00	101550.00	154.00
29.00	101800.00	173.00
31.00	102100.00	192.00
33.00	102550.00	211.00
35.00	102900.00	230.00
37.00	103500.00	248.00
39.00	104050.00	266.00
41.00	104550.00	284.00
43.00	105100.00	302.00
45.00	105700.00	320.00
47.00	106450.00	340.00
49.00	107100.00	360.00

Figure 3: Reservoir Editor: Physical Tab -- Pool



Elevation (ft)	Controlled (cfs)	Uncontrolled (cfs)	Total (cfs)
2.0	300.0	0.0	300.0
4.0	600.0	0.0	600.0
6.0	1,050.0	0.0	1,050.0
8.0	1,650.0	0.0	1,650.0
10.0	2,850.0	0.0	2,850.0
12.0	3,000.0	0.0	3,000.0
14.0	3,900.0	0.0	3,900.0
16.0	4,800.0	0.0	4,800.0
18.0	5,850.0	0.0	5,850.0
20.0	6,750.0	0.0	6,750.0
22.0	7,575.0	0.0	7,575.0
24.0	8,400.0	0.0	8,400.0
26.0	9,075.0	0.0	9,075.0
28.0	9,756.0	0.0	9,756.0
30.0	10,500.0	0.0	10,500.0
32.0	11,100.0	0.0	11,100.0
34.0	11,700.0	0.0	11,700.0
36.0	12,150.0	0.0	12,150.0
38.0	12,750.0	0.0	12,750.0
40.0	13,200.0	0.0	13,200.0
42.0	13,800.0	0.0	13,800.0
44.0	14,250.0	0.0	14,250.0

Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Townshend's "ExistingOps" operational zones, which consist of zones of Top of dam (126 ft), Surcharge (116 ft), Flood Control (96 ft), Conservation (21 ft), and Inactive zone (0 ft).

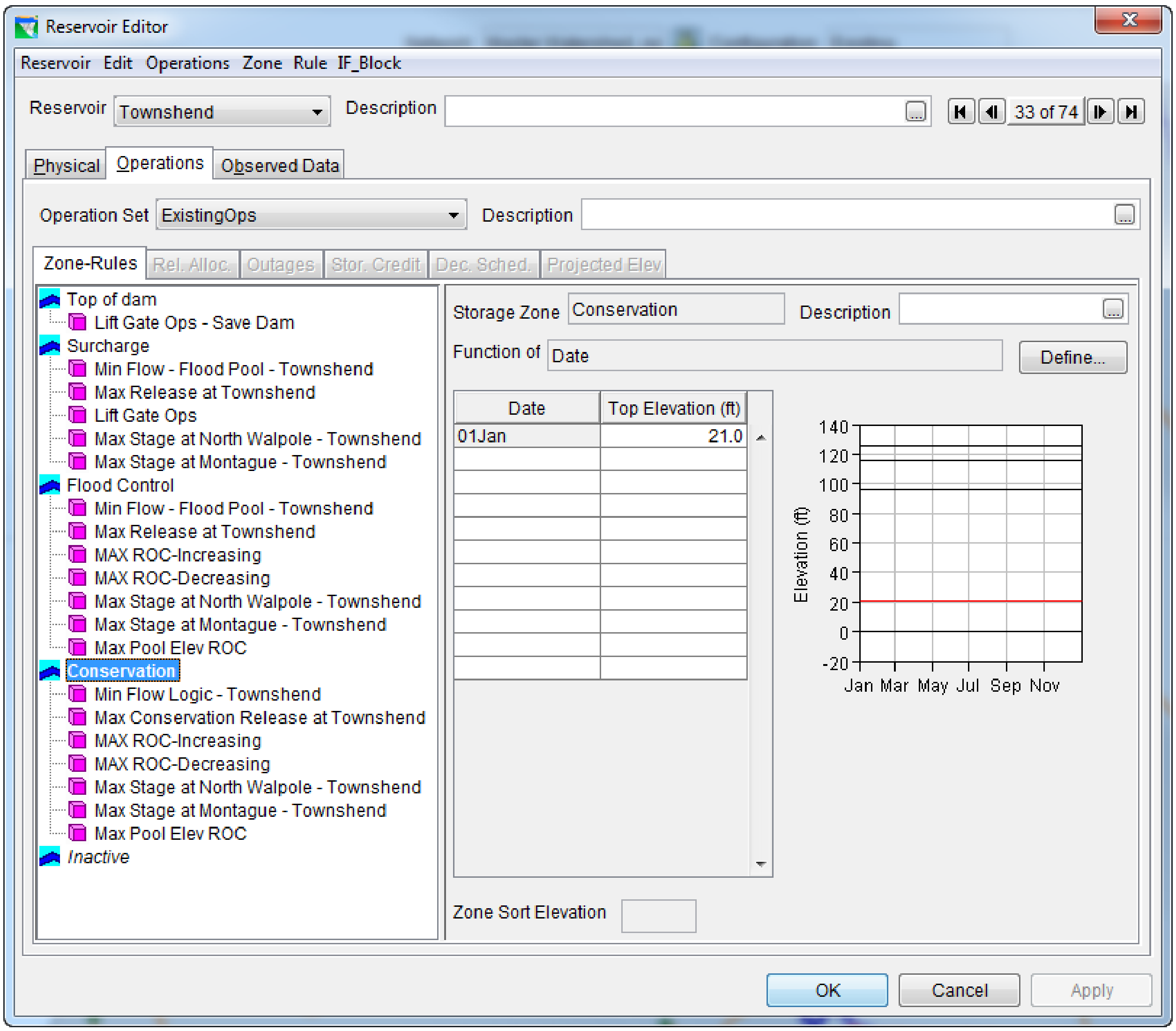


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

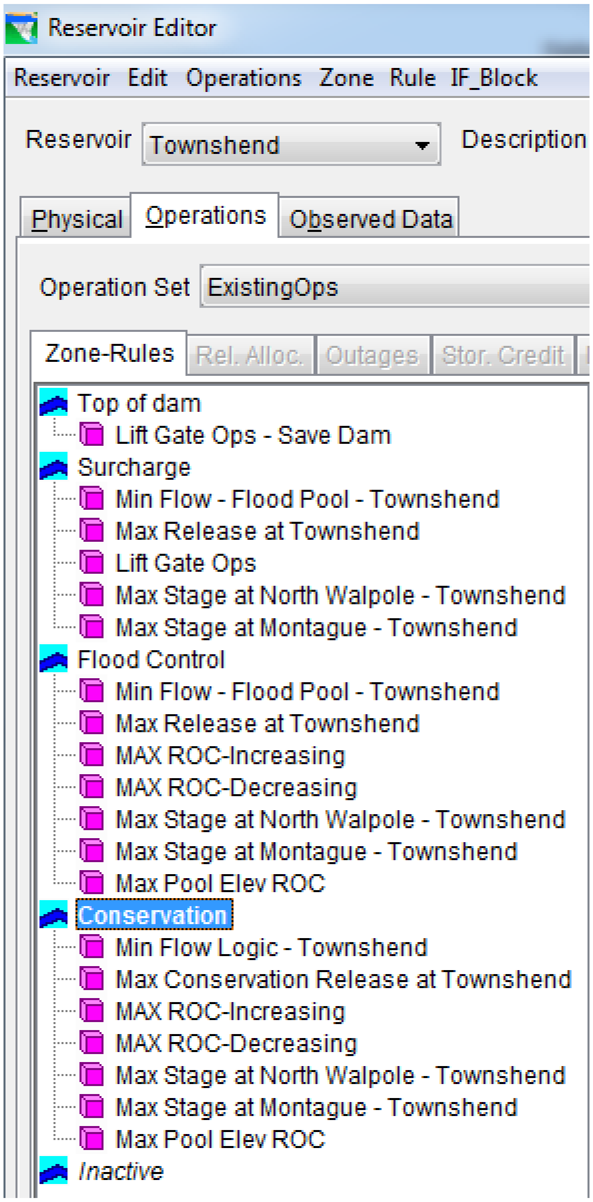


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Lift Gate Ops-Save Dam

Figure 7 shows the content of “Lift Gate Ops-Save Dam” rule. This rule represents the maximum allowable release from Lift gates when the pool is in Top of dam zone as a function of pool elevation.

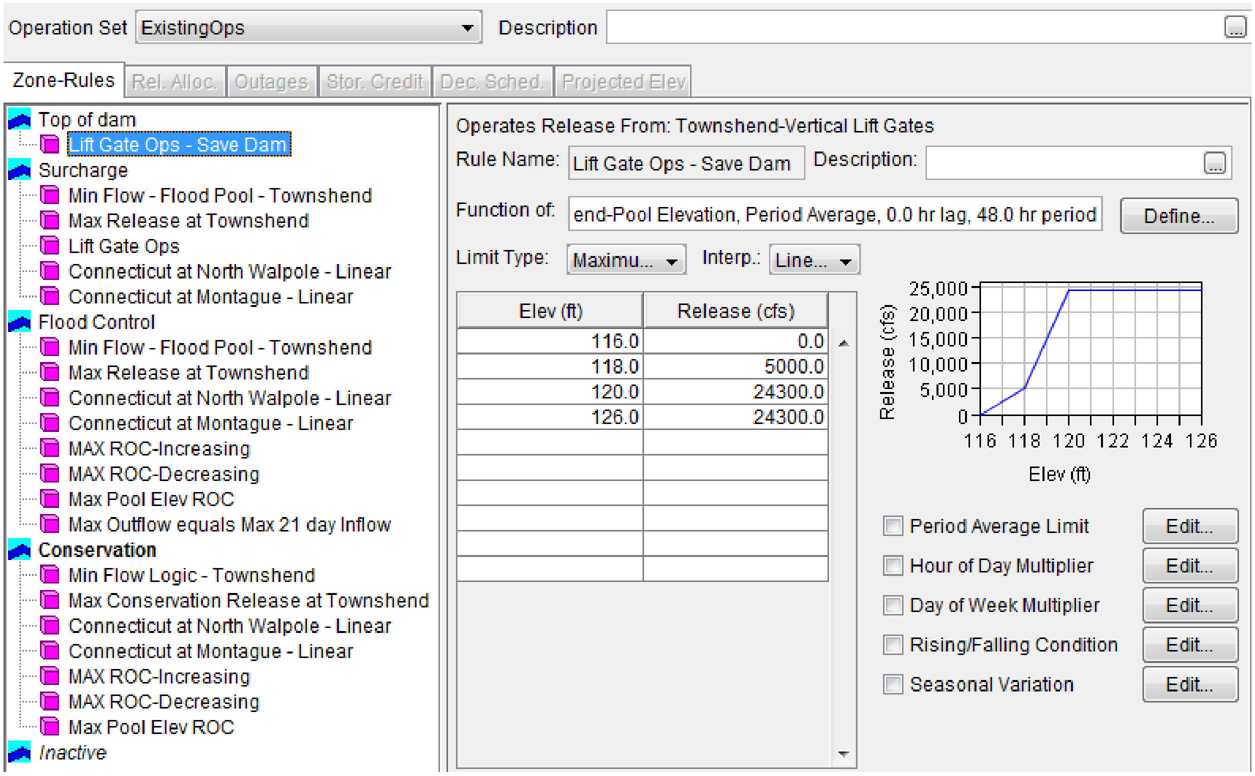


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Lift Gate Ops-Save Dam

2. *Min Flow-Flood Pool-Townshend*

Figure 8 shows the content of "Min Flow-Flood pool-Townshend" rule. This rule represents the minimum required release from dam during flood control operations.

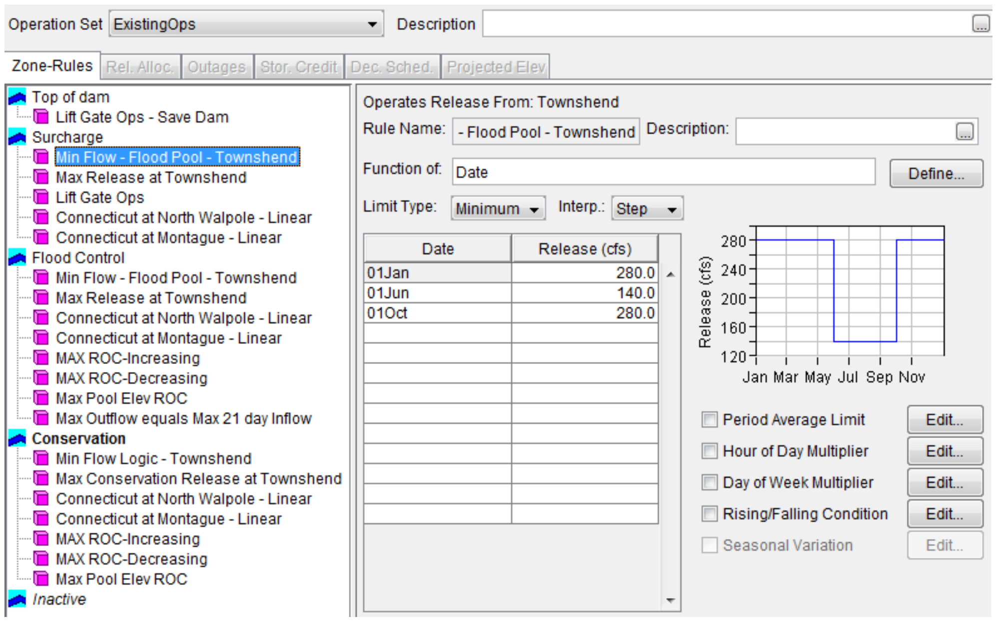


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow-Flood pool-Townshend

3. *Max Release at Townshend*

Figure 9 shows the content of "Max release at Townshend" rule. This rule assigns 9000 cfs as a maximum release from dam.

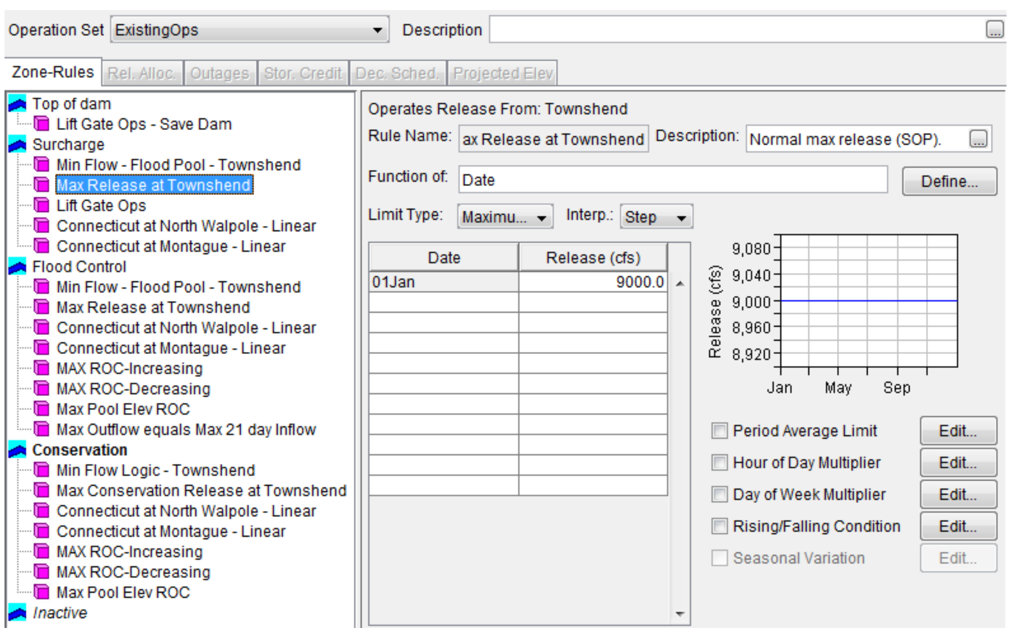


Figure 9 Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Release at Townshend

4. *Lift Gate Ops*

Figure 10 shows the content of "Lift Gate Ops" rule. This rule represents the maximum allowable release from Lift gates as a function of pool elevation when pool is in surcharge zone.

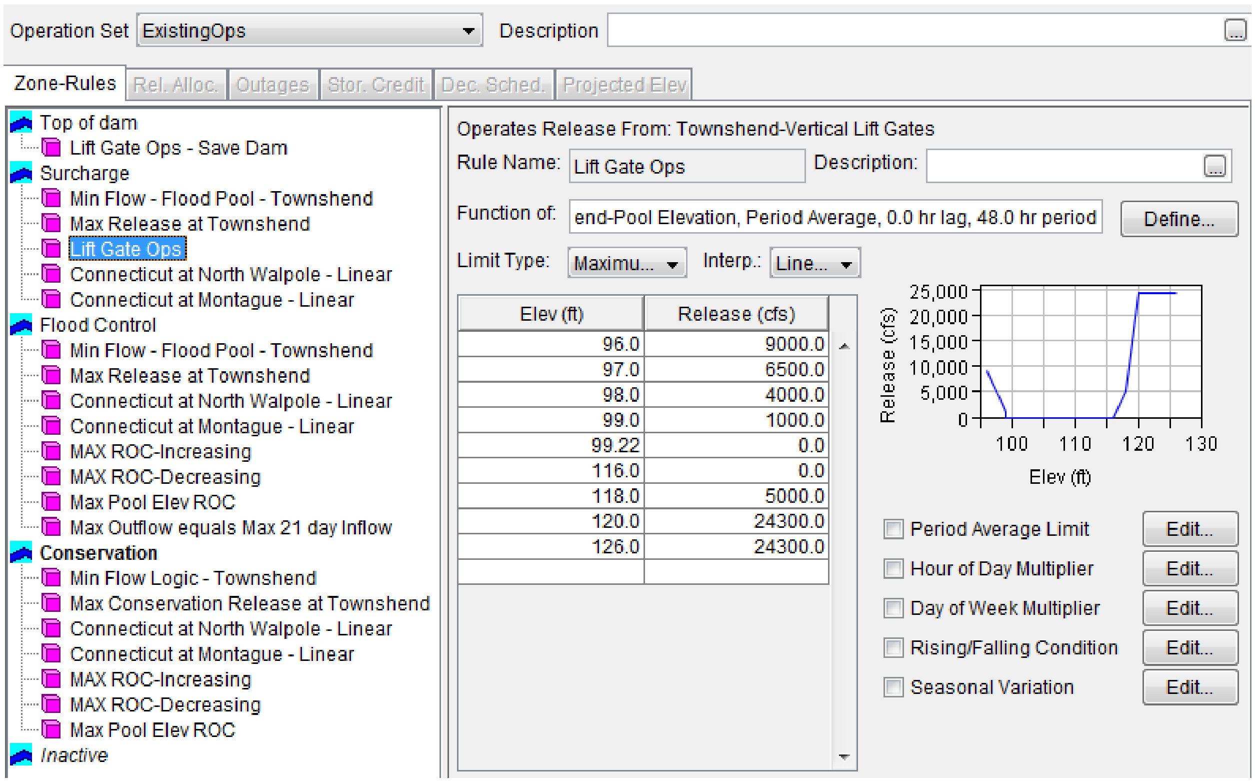


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Lift Gate Ops

5. Connecticut at North Walpole-Linear

Figure 11 shows the content of "Connecticut at North Walpole-Linear" rule. This rule represents the maximum allowable release from dam as a function of previous day stage at North Walpole. The SOP for Townshend was slightly different than the other flood control dams in that it called for an immediate reduction to 3000 cfs when a mainstem stage target was exceeded. Then the SOP says that the outflow will be directed by the Reservoir Regulation Team. The immediate reduction to 3000 cfs was accounted for in the rule and then 3000 cfs was used as the maximum when applying the linear release cutback described in the Simulation/Verification section of the report. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

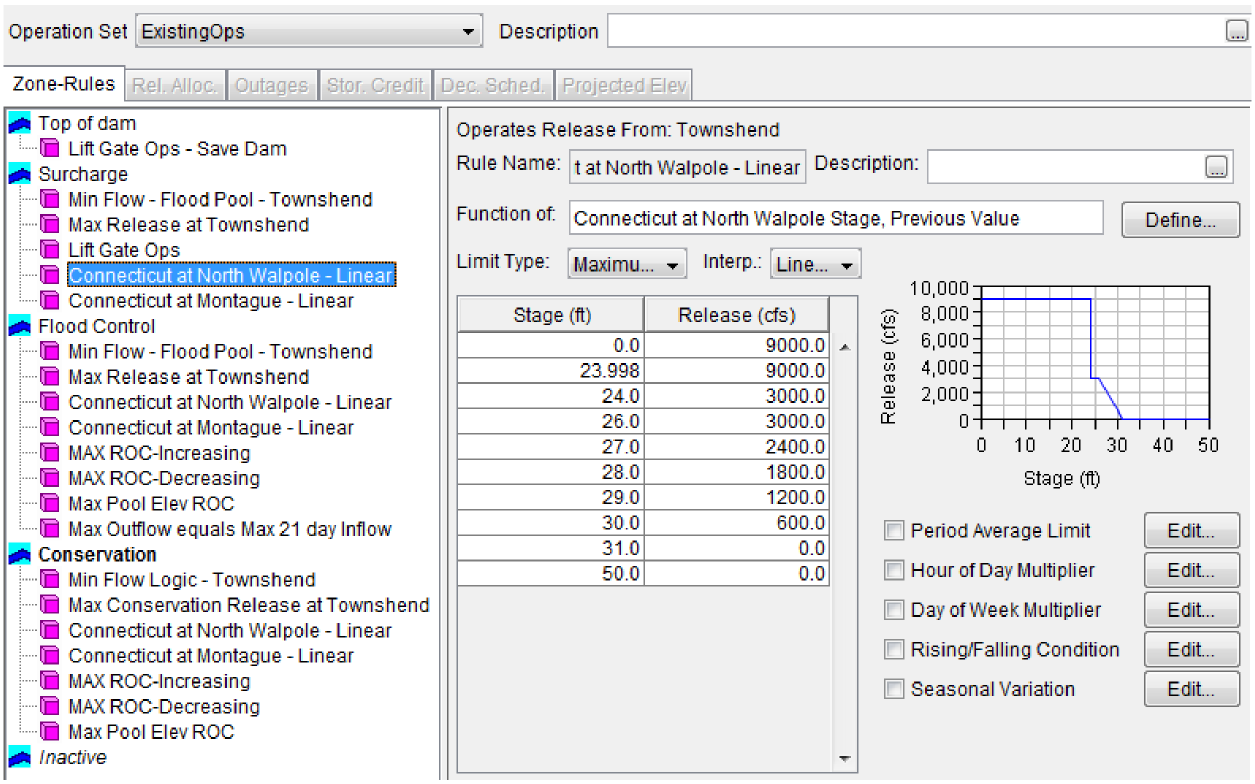


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at North Walpole-Linear

6. *Connecticut at Montague-Linear*

Figure 12 shows the content of “Connecticut at Montague-Linear” rule. This rule represents the maximum allowable release from dam as a function of previous day stage at Montague. The SOP for Townshend was slightly different than the other flood control dams in that it called for an immediate reduction to 3000 cfs when a mainstem stage target was exceeded. Then the SOP says that the outflow will be directed by the Reservoir Regulation Team. The immediate reduction to 3000 cfs was accounted for in the rule and then 3000 cfs was used as the maximum when applying the linear release cutback described in the Simulation/Verification section of the report. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

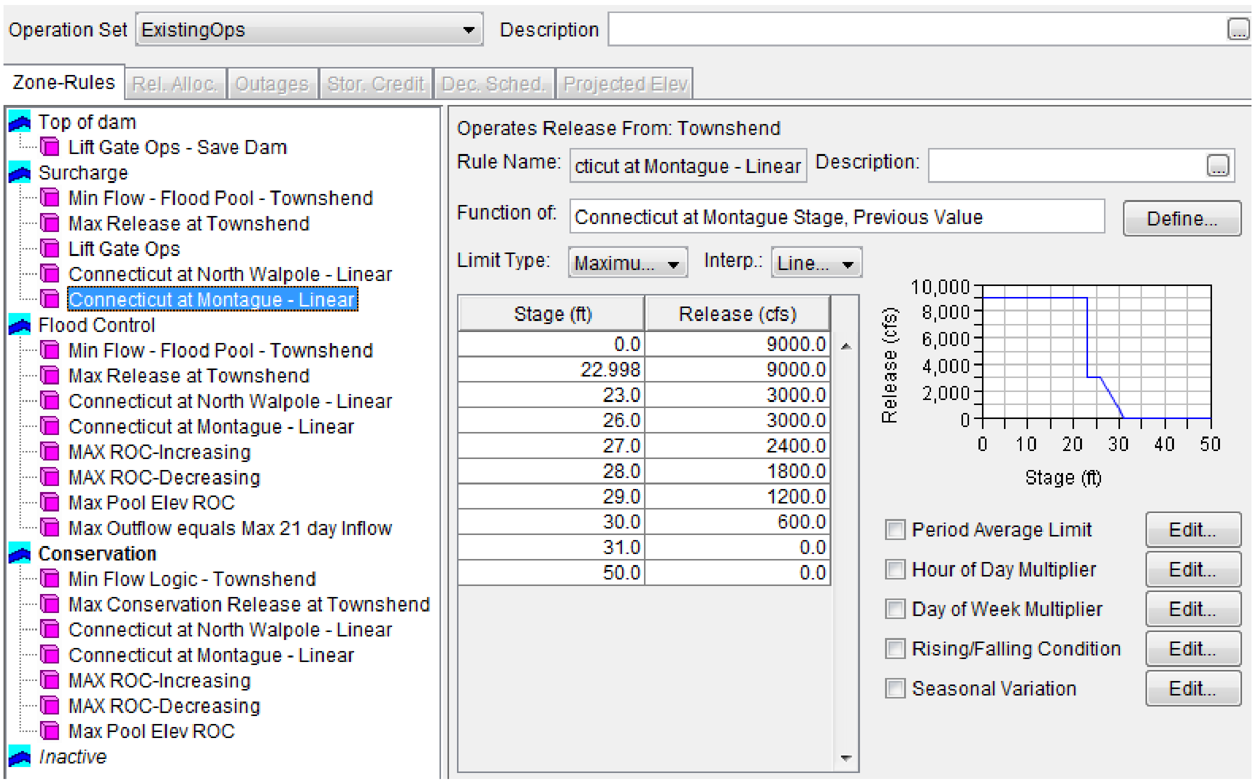


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague-Linear

7. *MAX ROC-Increasing*

Figure 13 shows the content of "MAX ROC-Increasing" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Townshend dam.

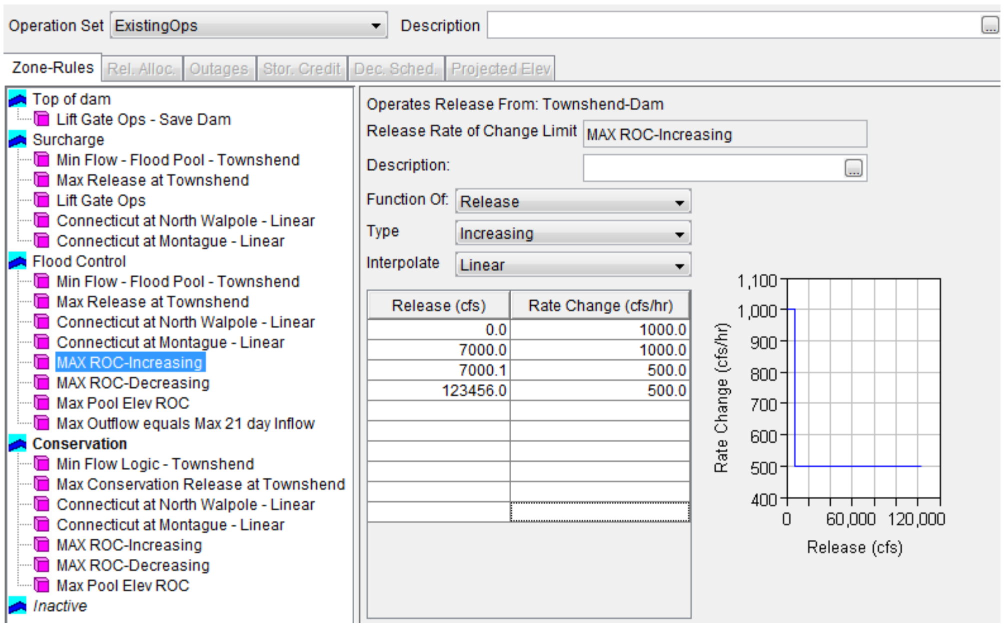


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – MAX ROC-Increasing

8. *MAX ROC-Decreasing*

Figure 14 shows the content of "MAX ROC-Decreasing" rule. This rule shows the maximum allowable decreasing release rate of change from Townshend dam.

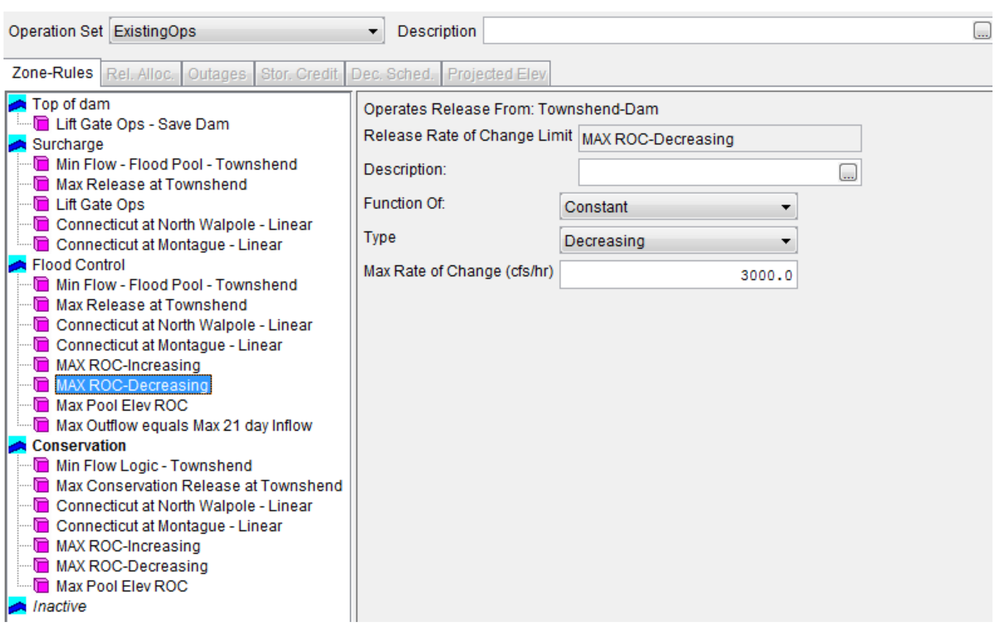


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet – MAX ROC-Decreasing

9. *Max Pool Elev ROC*

Figure 15 shows the content of "Max Pool Elev ROC" rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

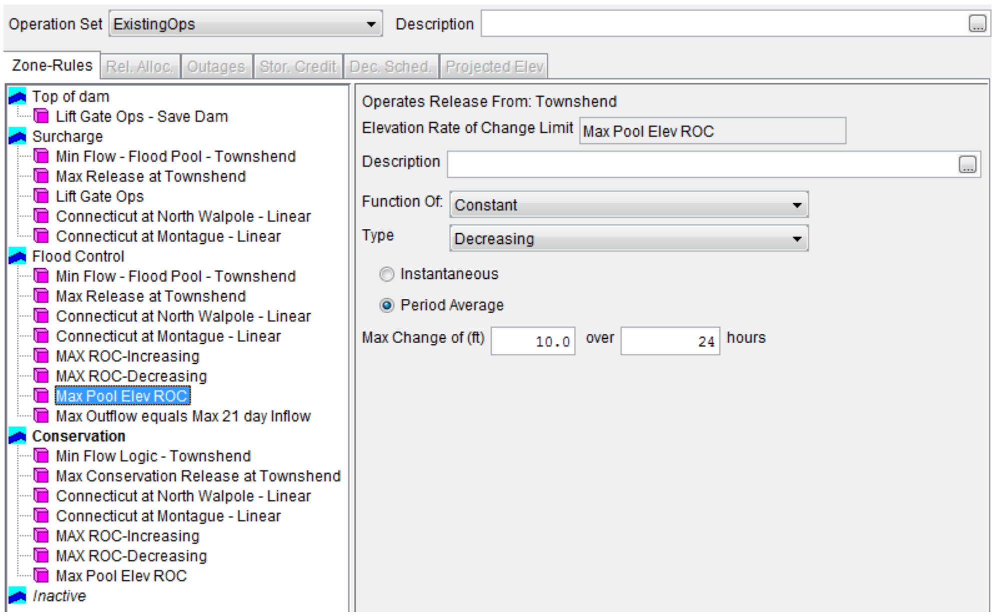


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Pool Elev ROC

10. *Max Outflow equals Max 21 day Inflow*

Figure 16 shows the content of "Max Outflow equals Max 21 day Inflow" rule. This rule represents the maximum release from dam as a function of Inflow.

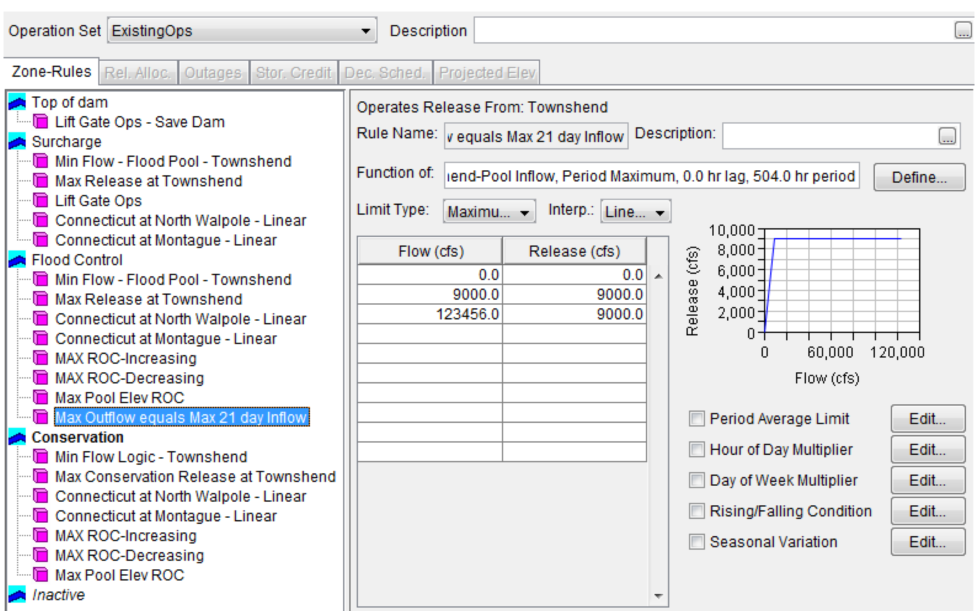


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals Max 21 day Inflow

11. Min Flow Logic-Townshend

Figure 17 shows the content of "Min Flow Logic-Townshend" rule. This rule describes required seasonal minimum flows from controlled outlets as a function of inflow at Townshend.

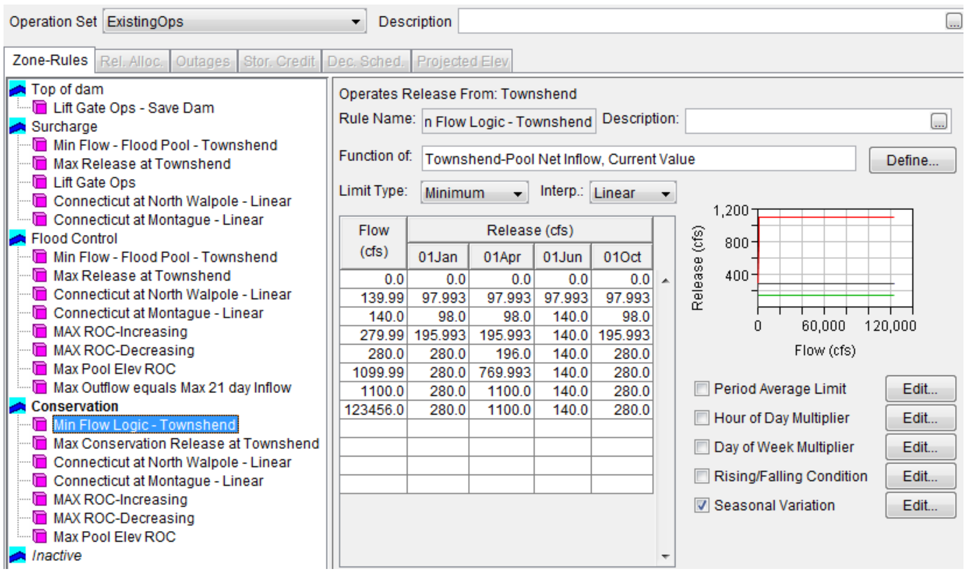


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min flow Logic-Townshend

12. Max Conservation Release at Townshend

Figure 18 shows the content of "Max Conservation Release at Townshend" rule. This rule represents the maximum allowable release from Townshend when the pool is in the conservation zone. This rule is unique to Ball Mountain and Townshend.

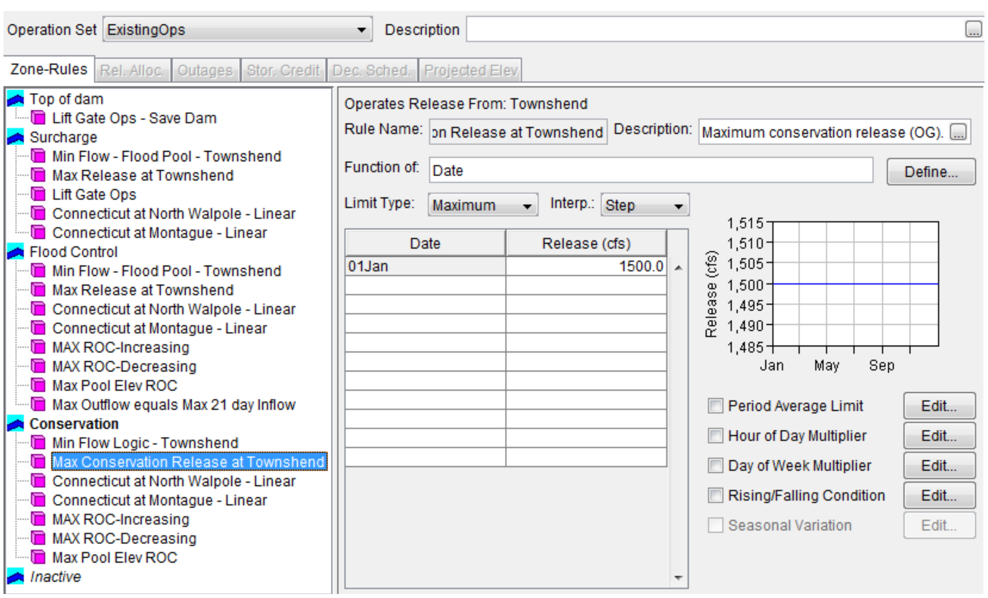


Figure 18: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max conservation Release at Townshend

Tully

I. Overview

Tully Lake dam is a dam located in Royalston, Massachusetts on the Millers River. It was constructed in 1949 by the US Army Corps of Engineers and is still owned and operated by the Corps. It is primarily used for flood control purposes but also for recreation.

Figure 1 shows the location of Tully Dam as it is represented in the HEC-ResSim model, and Figure 2 shows the photo from Tully dam.

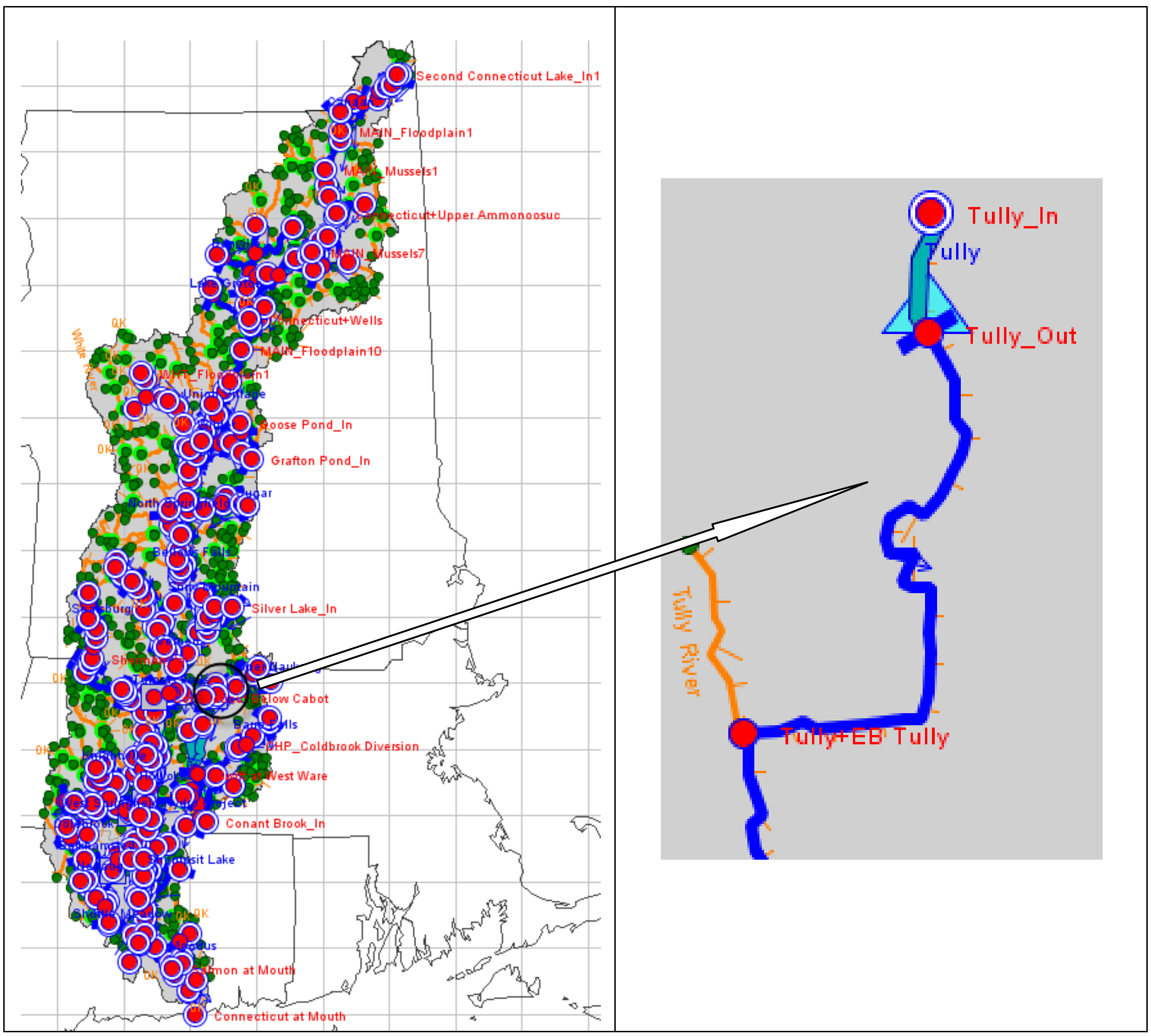


Figure 1: HEC-ResSim Map Display Showing Location of Tully dam

Figure 2: Photo of Tully Lake dam.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled slide gates, and (2) uncontrolled spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[98].

[98] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index

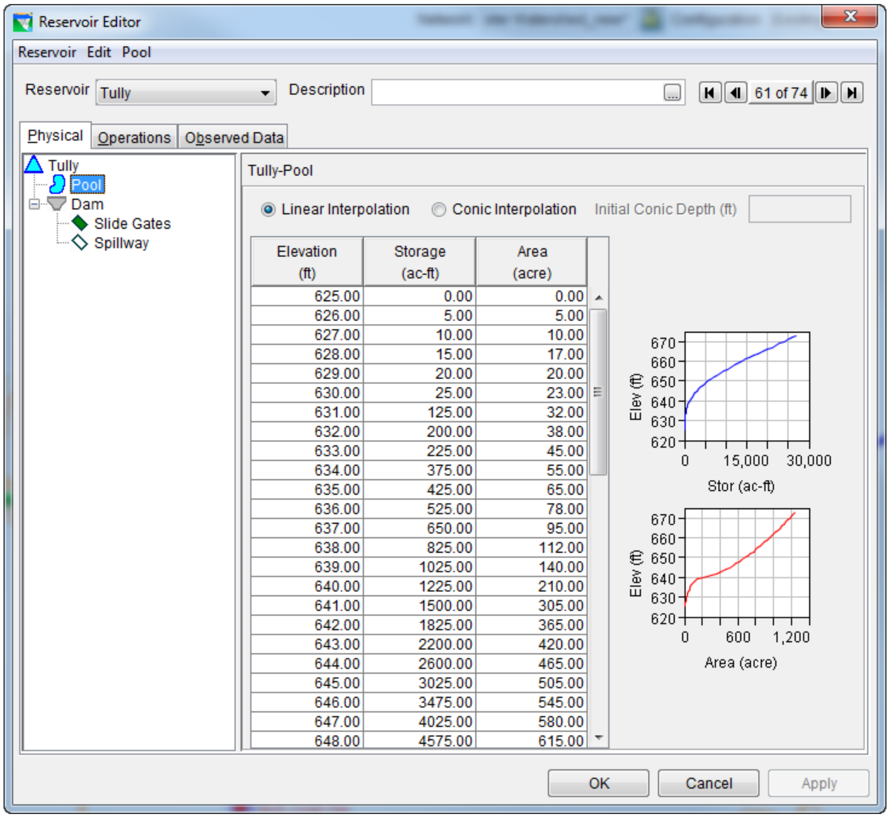


Figure 3: Reservoir Editor: Physical Tab -- Pool

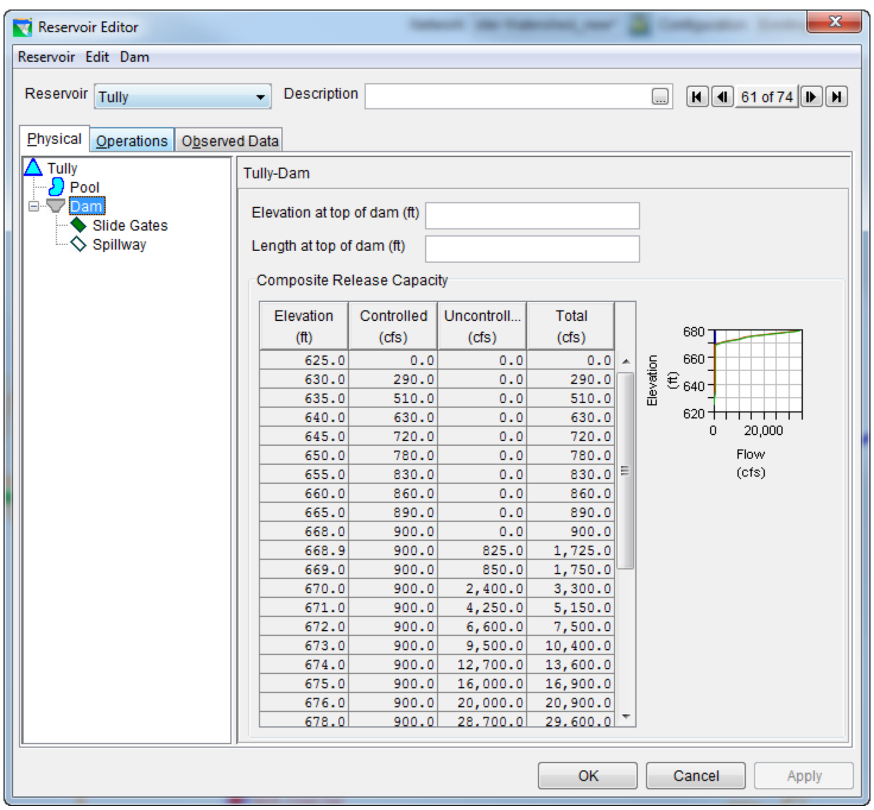


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Tully's "ExistingOps" operational zones, which consist of zones of Excess Surcharge (684 ft), Surcharge Storage (672 ft), Flood Control (668 ft), Conservation (638-641 ft), and Inactive zone (625 ft).

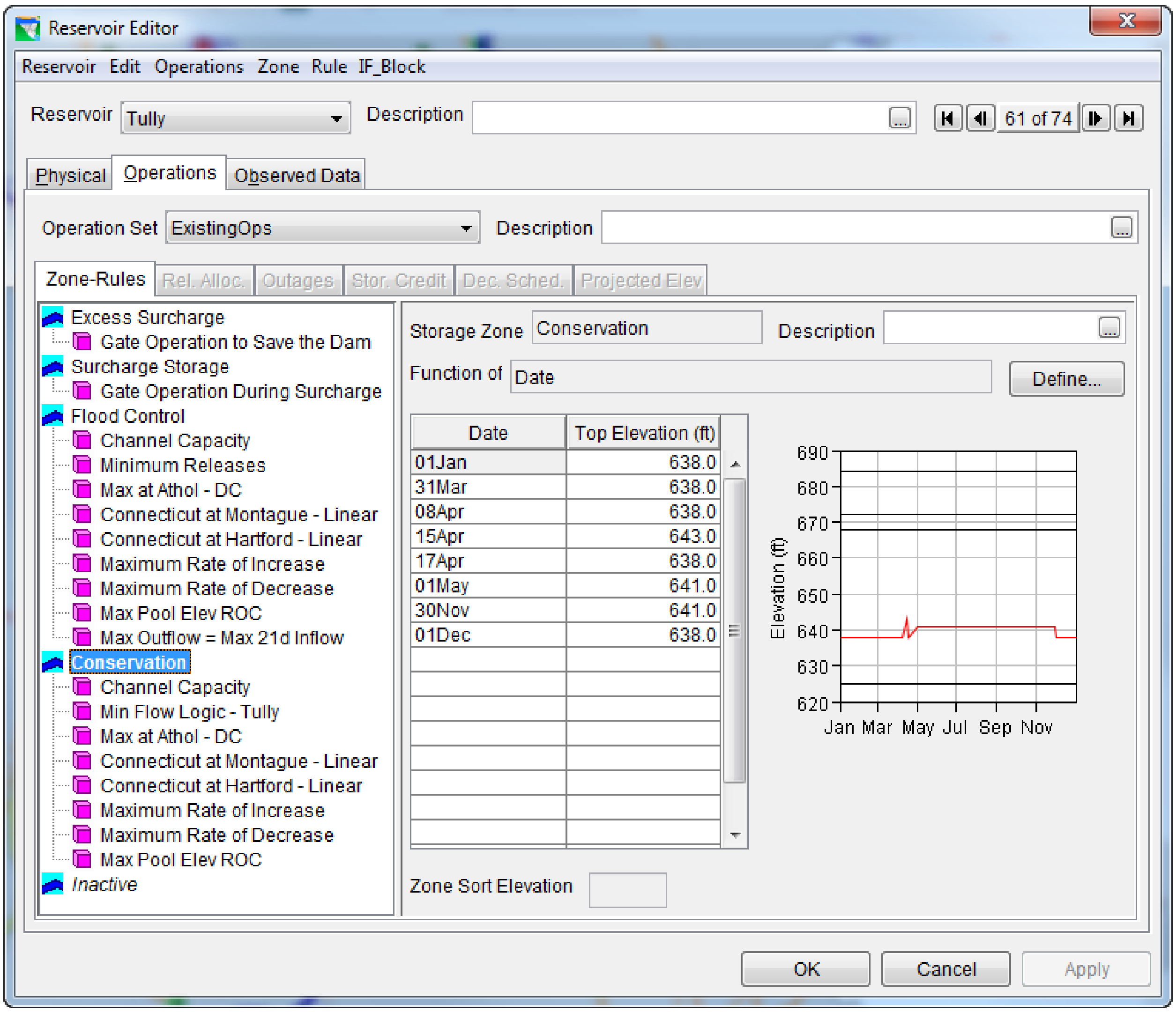


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

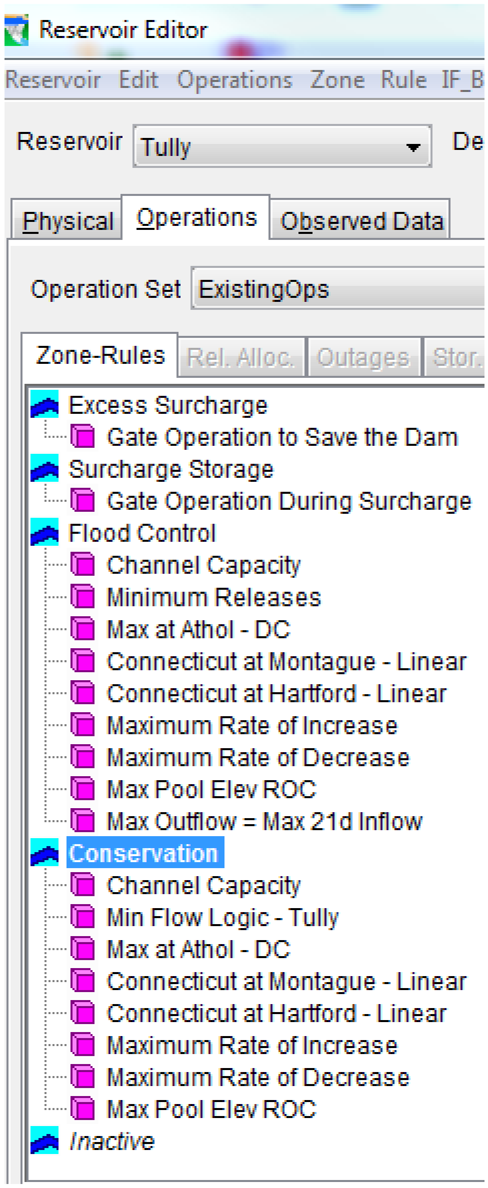


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Gate Operation to Save Dam

Figure 7 shows the content of “Gate Operation to Save Dam” rule. This rule represents the maximum allowable release from Slide gates as a function of pool elevation when the pool is in Excess Surcharge zone.

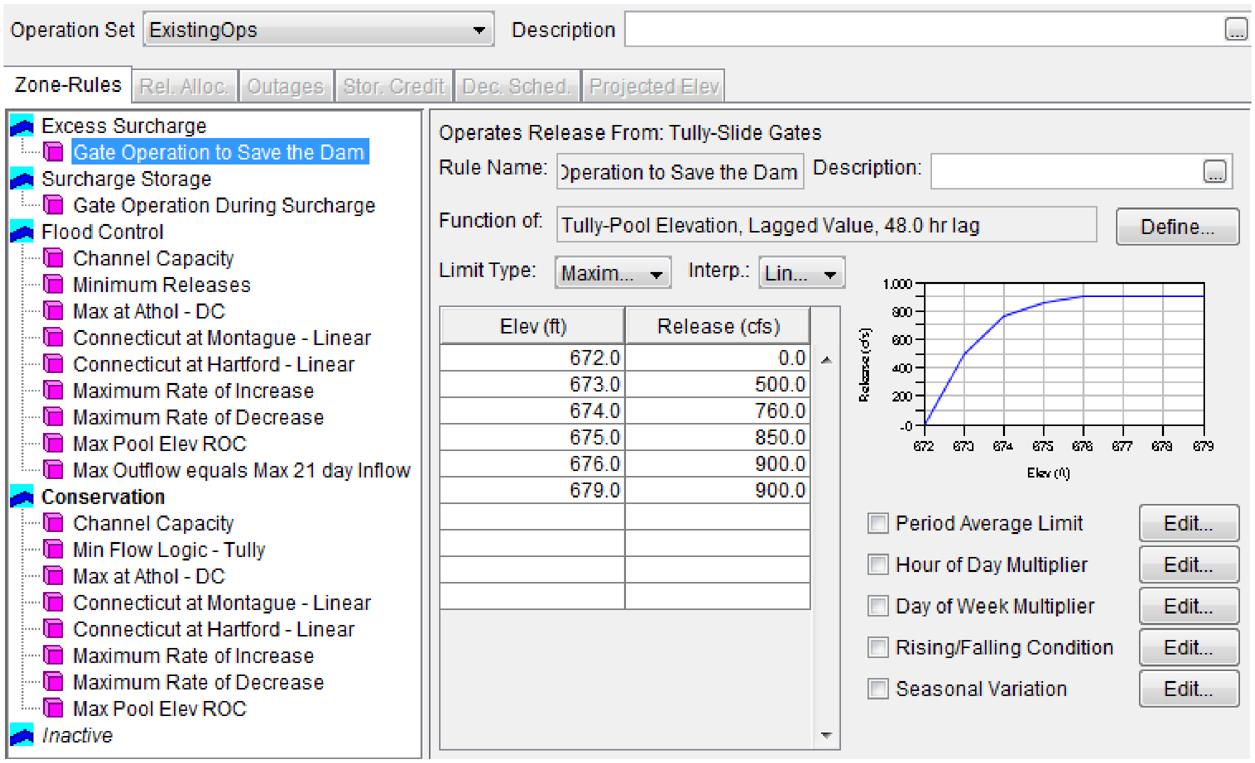


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet –Gate Operation to Save Dam

2. *Gate Operation During Surcharge*

Figure 8 shows the content of "Gate Operation During Surcharge" rule. This rule represents the maximum allowable release from Tully as a function of pool elevation when the pool is in Surcharge storage zone.

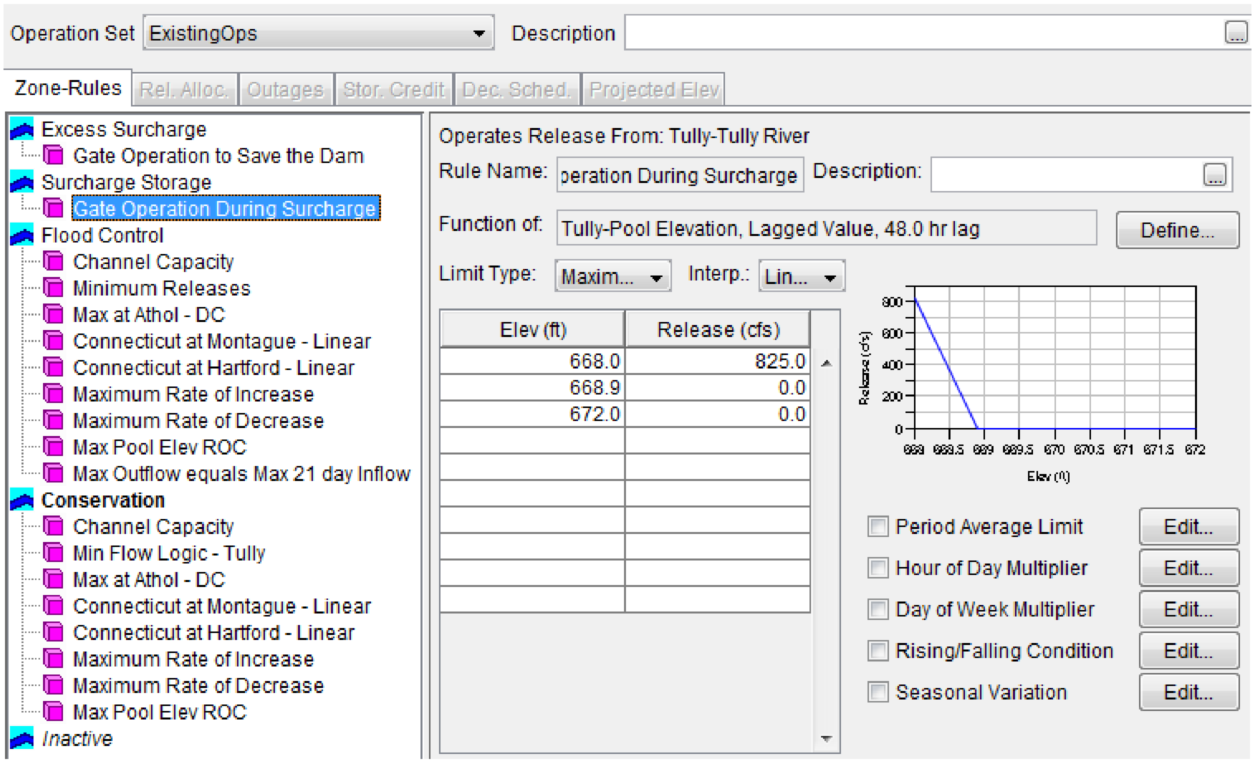


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet –Gate Operation During Surcharge

3. *Channel Capacity*

Figure 9 shows the content of "Channel Capacity" rule. This rule shows the maximum allowable release from Tully.

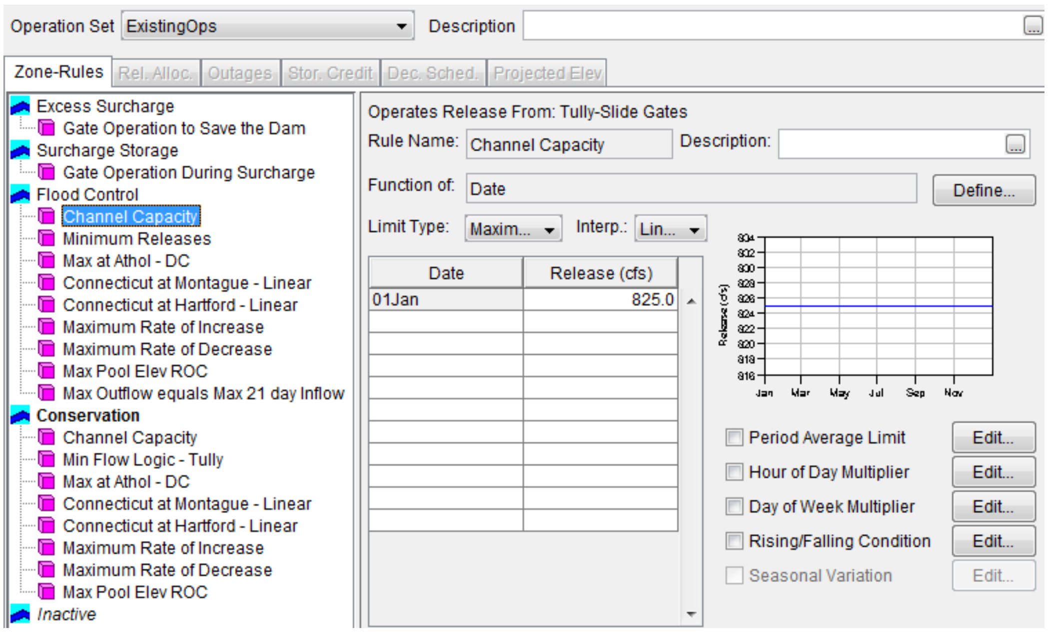


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet –Channel Capacity

4. *Minimum Releases*

Figure 10 shows the content of "Minimum Releases" rule. This rule shows the minimum required release from dam during flood control operations.

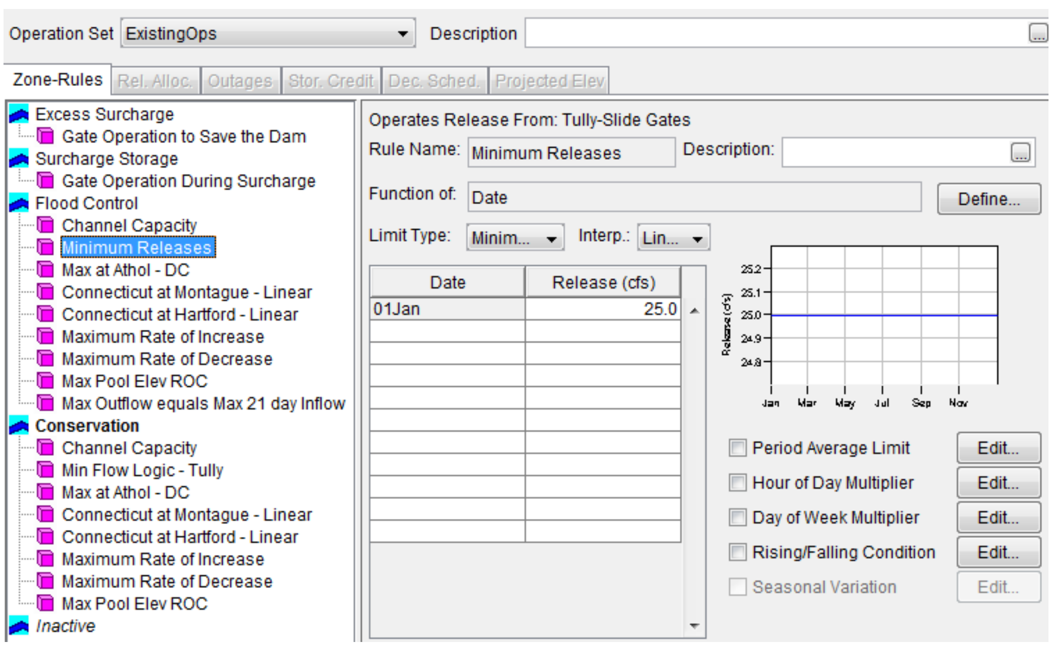


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet –Minimum Releases

5. *Max at Athol-DC*

Figure 11 shows the content of “Max at Athol-DC” rule. This rule shows the maximum allowable flow at the downstream location Millers at Athol.

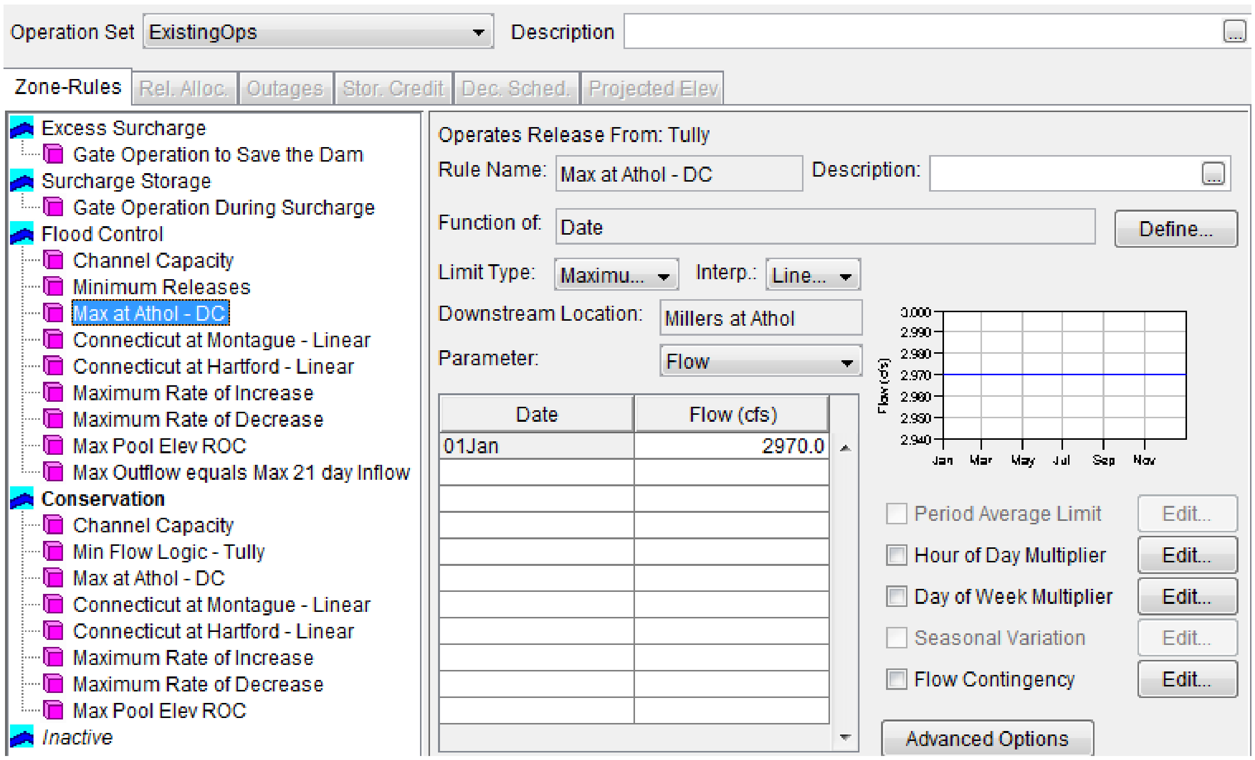


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max at Athol-DC

6. Connecticut at Montague-Linear

Figure 12 shows the content of “Connecticut at Montague-Linear” rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montague. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

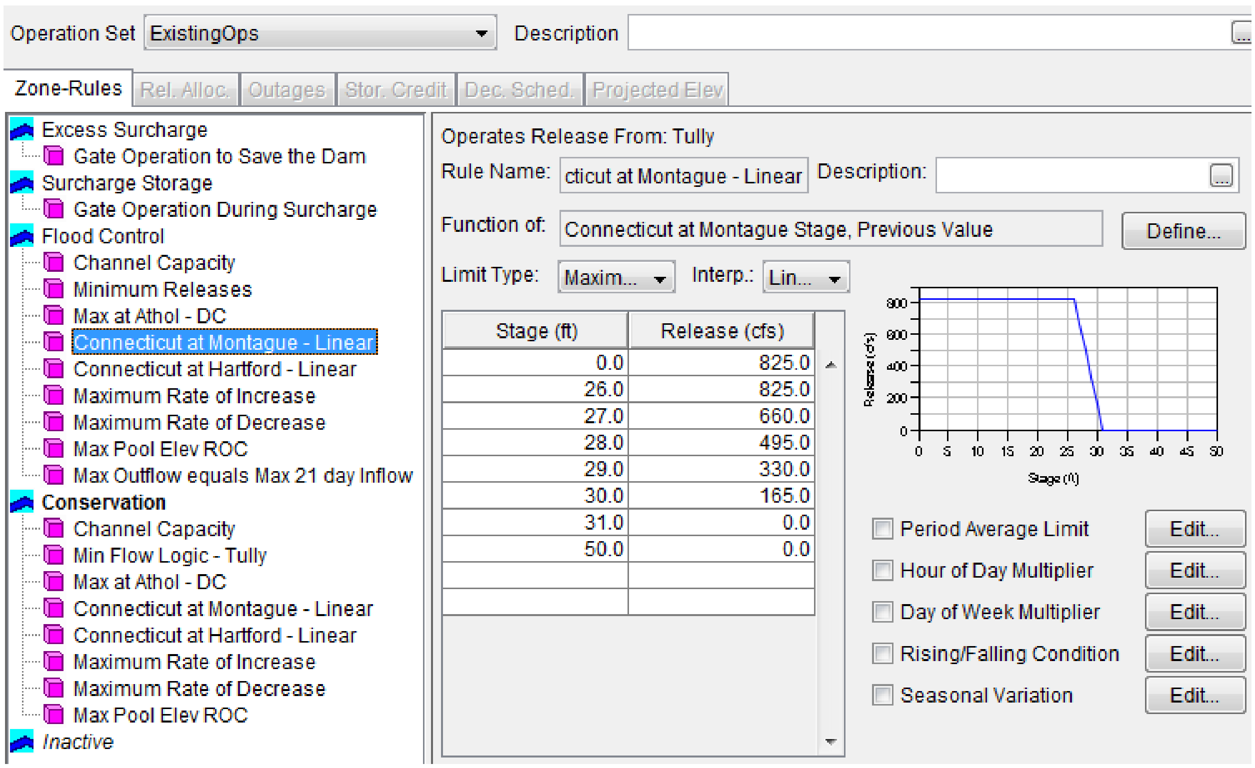


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet –Connecticut at Montague-Linear

7. *Connecticut at Hartford-Linear*

Figure 13 shows the content of "Connecticut at Hartford-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Hartford. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

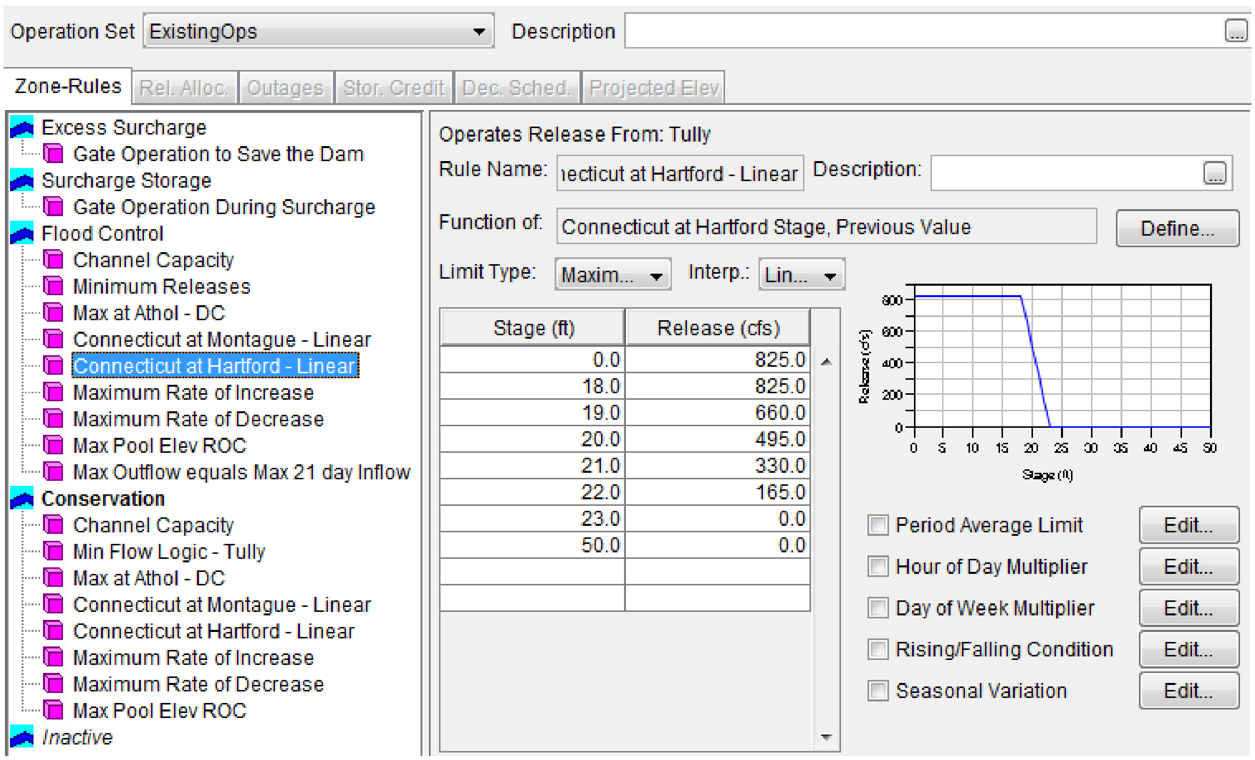


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Hartford-Linear

8. Maximum Rate of Increase

Figure 14 shows the content of "Maximum Rate of Increase" rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Tully.

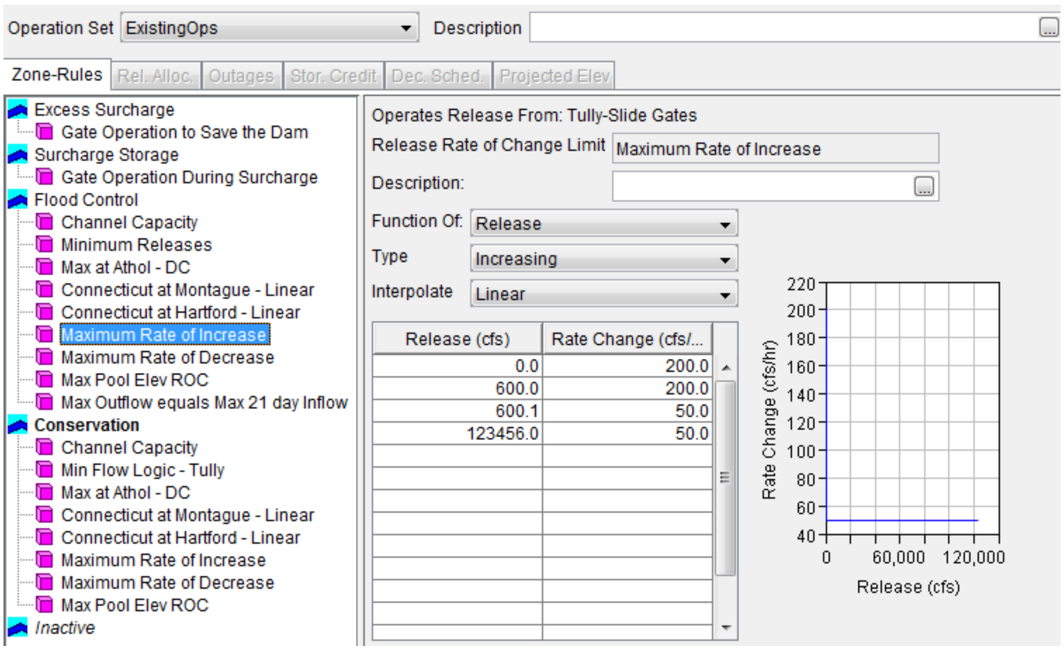


Figure 14: Reservoir Editor: Operations Tab – Existing Ops OpSet –Maximum Rate of Increase

9. Maximum Rate of Decrease

Figure 15 shows the content of "Maximum Rate of Decrease" rule. This rule shows the maximum allowable decreasing release rate of change.

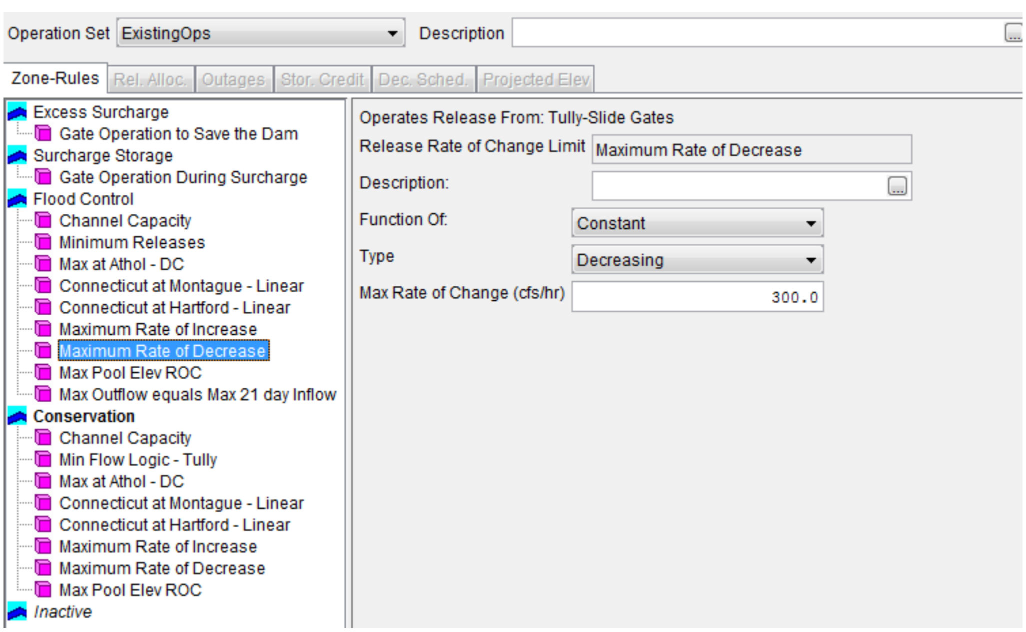


Figure 15: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maximum Rate of Decrease

10. Max Pool Elev ROC

Figure 16 shows the content of “Max Pool Elev ROC” rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

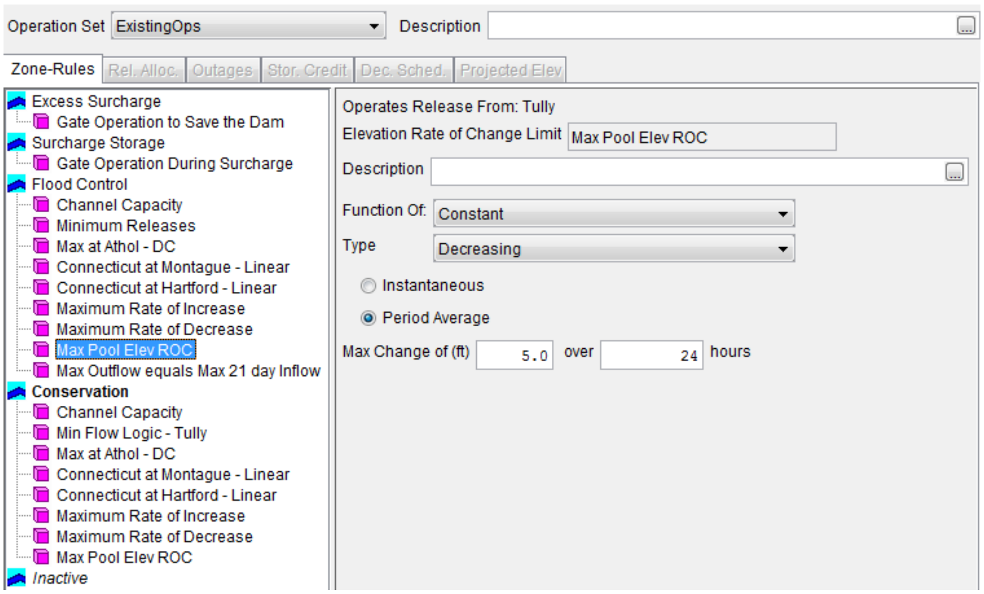


Figure 16: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max Pool Elev ROC

11. Max Outflow equals Max 21 day Inflow

Figure 17 shows the content of “Max Outflow equals Max 21 day Inflow” rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

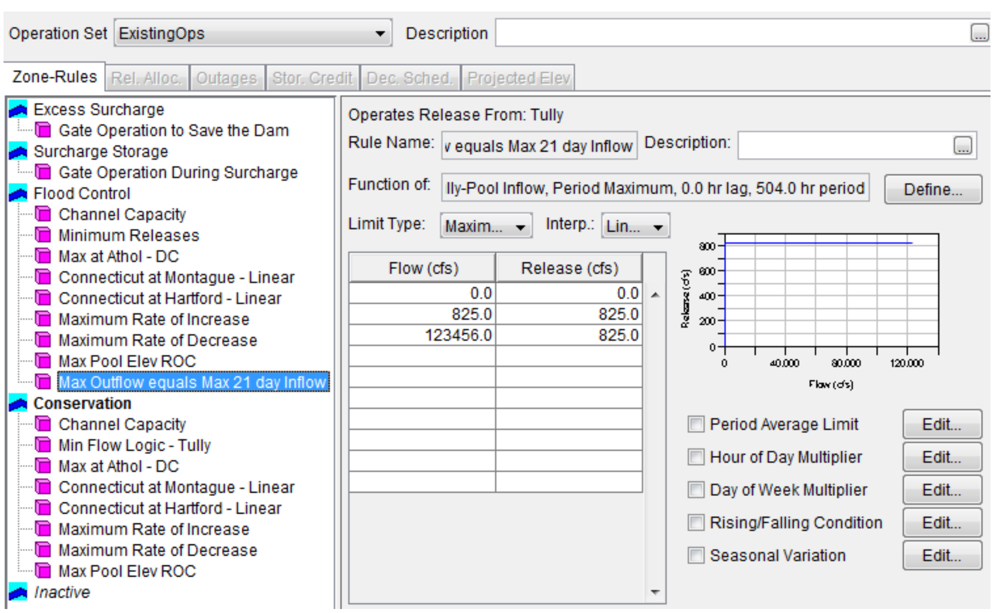


Figure 17: Reservoir Editor: Operations Tab – Existing Ops OpSet –Max Outflow equals Max 21 day Inflow

12. *Min Flow Logic-Tully*

Figure 18 shows the content of "Min Flow Logic-Tully" rule. This rule provides seasonal minimum releases from Tully as a function of inflow.

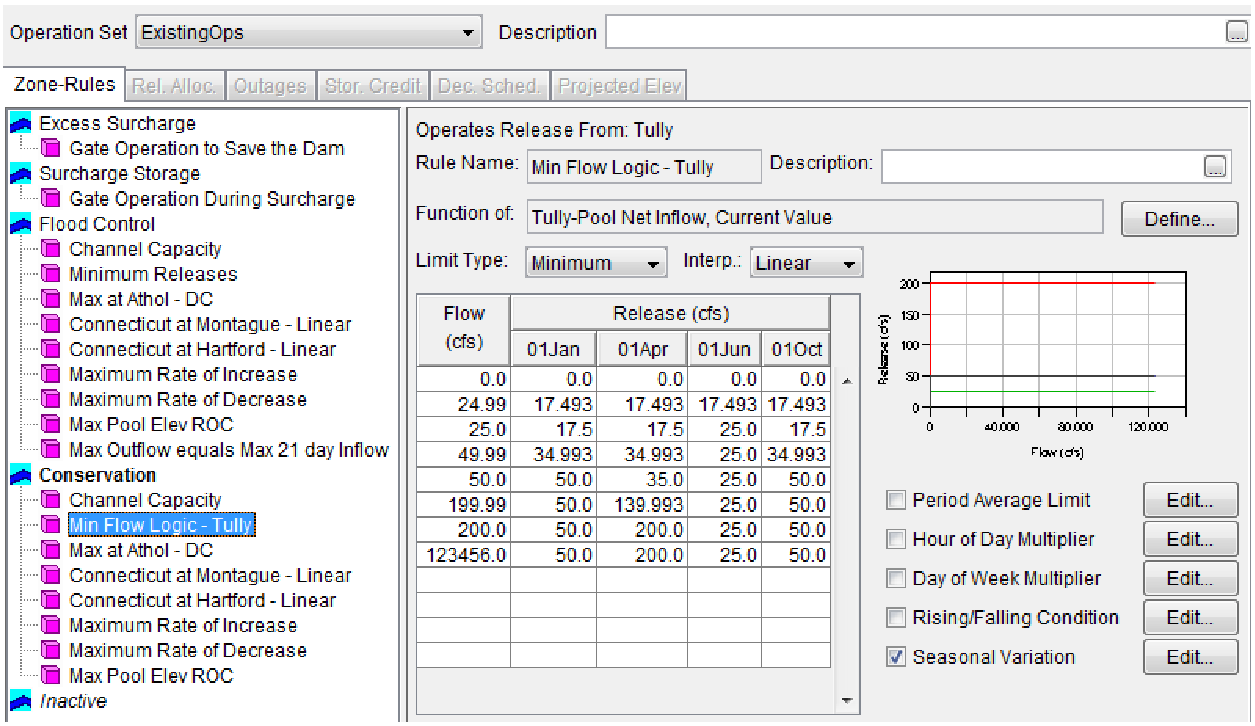


Figure 18 Reservoir Editor: Operations Tab – Existing Ops OpSet –Min Flow Logic-Tully

Turners Falls

I. Overview

Turners Falls dam is located on the mainstem Connecticut River directly downstream of Northfield Mountain and the confluence with the Millers River. FirstLight Power Resources owns and operates Turners Falls which is used to generate hydropower at two downstream stations (one of those stations is modeled as a separate reservoir, Power Canal). It is also operated in connection with Northfield Mountain, another FirstLight Power Resources project.

Figure 1 shows the location of Turners Falls dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo from Turners Falls dam.

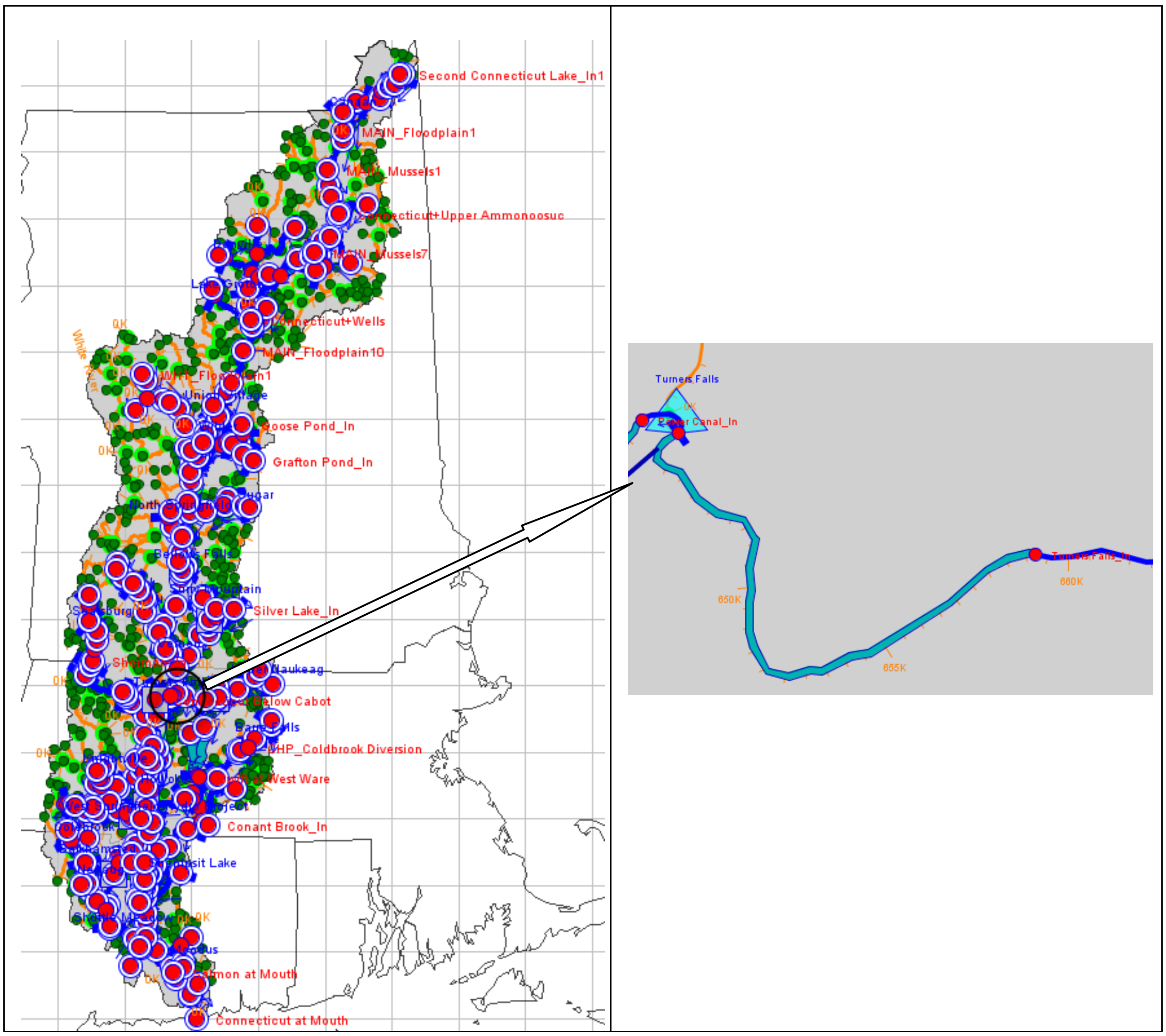


Figure 1: HEC-ResSim Map Display Showing Location of Turners Falls dam

Figure 2: Photo from Turners Falls dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[99]. The dam consists of two types of outlets: (1) controlled Gatehouse to Canal, and (2) controlled spillway Gates, as shown in Figure 4.

[99] All physical and operational data from ResSim model developed by Gomez and Sullivan Engineers, P.C.

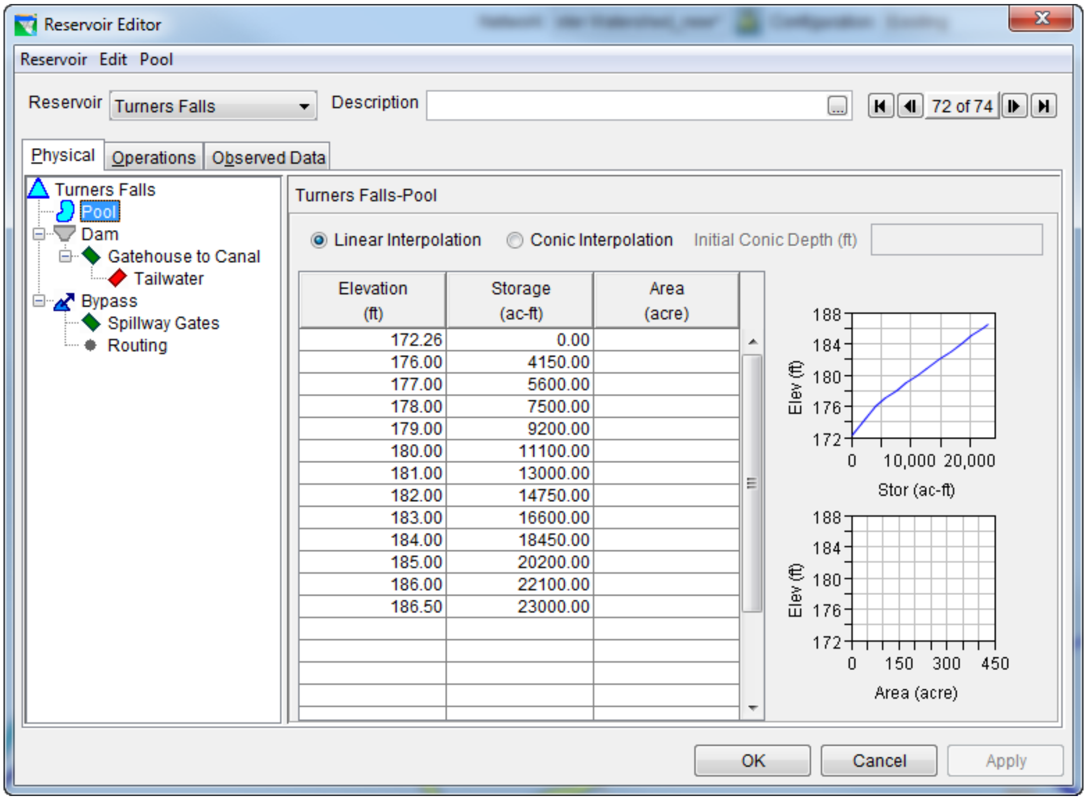


Figure 3: Reservoir Editor: Physical Tab -- Pool

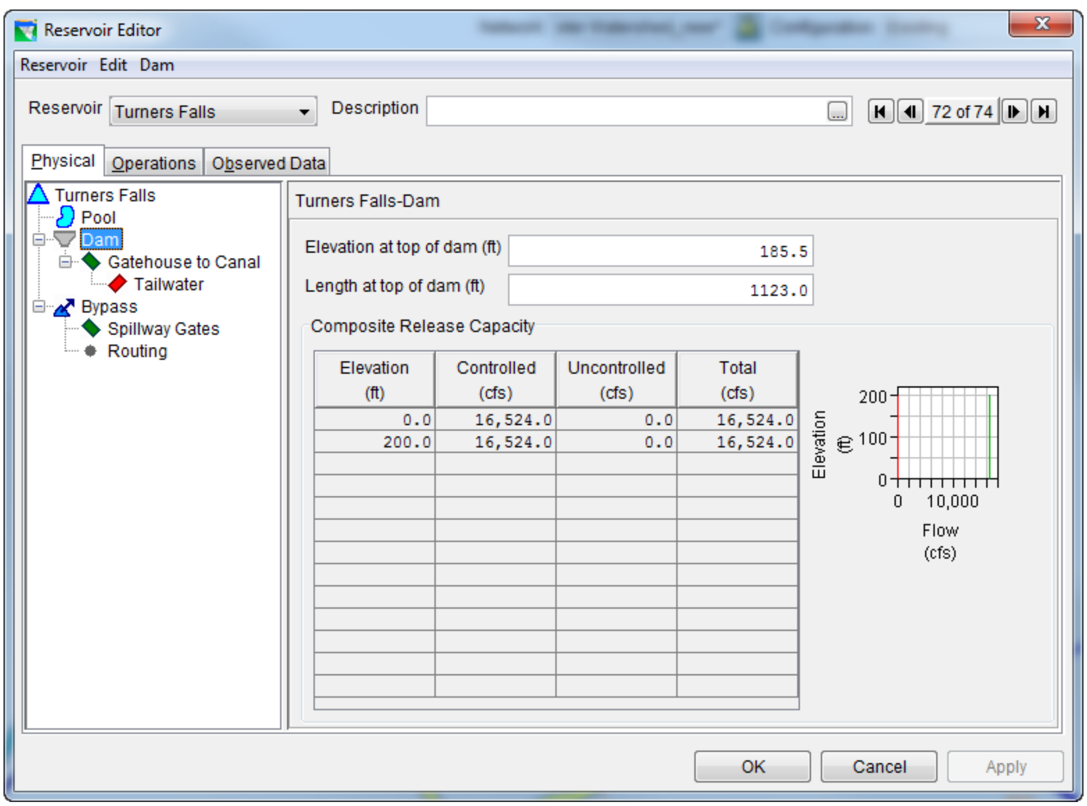


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Turners Falls's "ExistingOps" operational zones, which consist of zones of Flood Control (185.5 ft), FERC Max Pool (185 ft), Normal pool (181.3 ft), Buffer (179 ft), and Inactive zone (176 ft)[1].

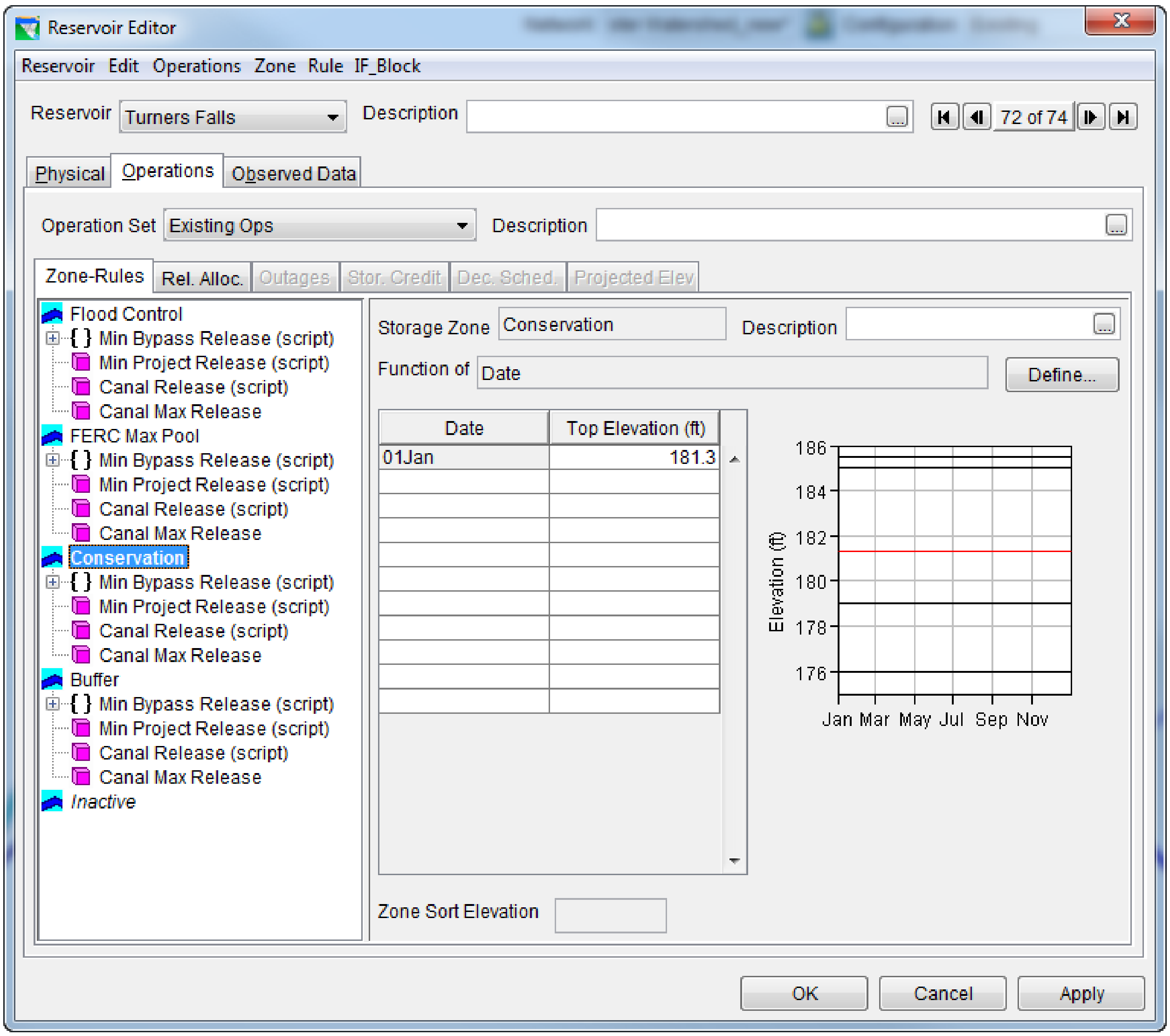


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops.

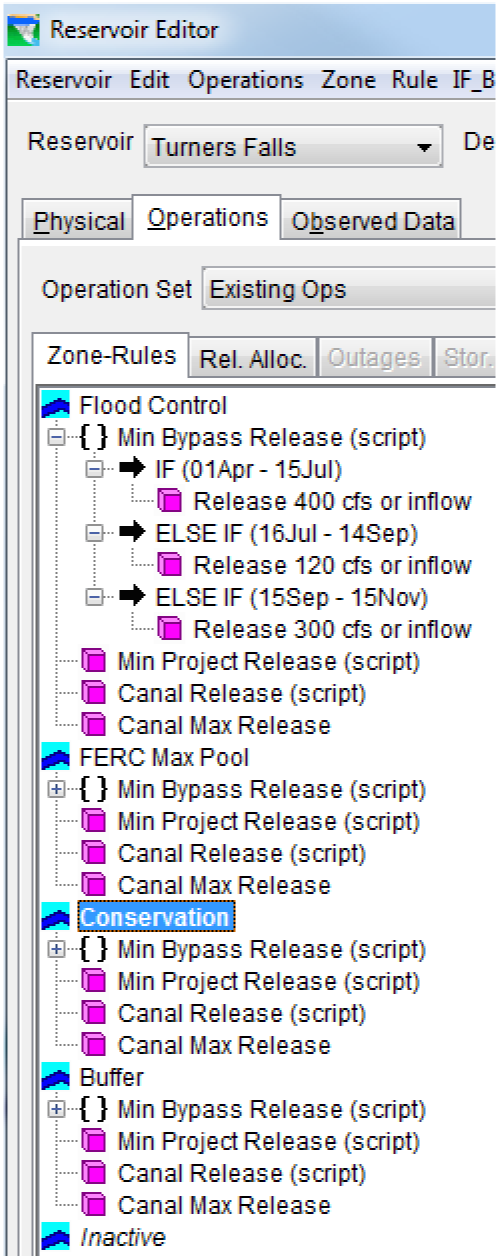
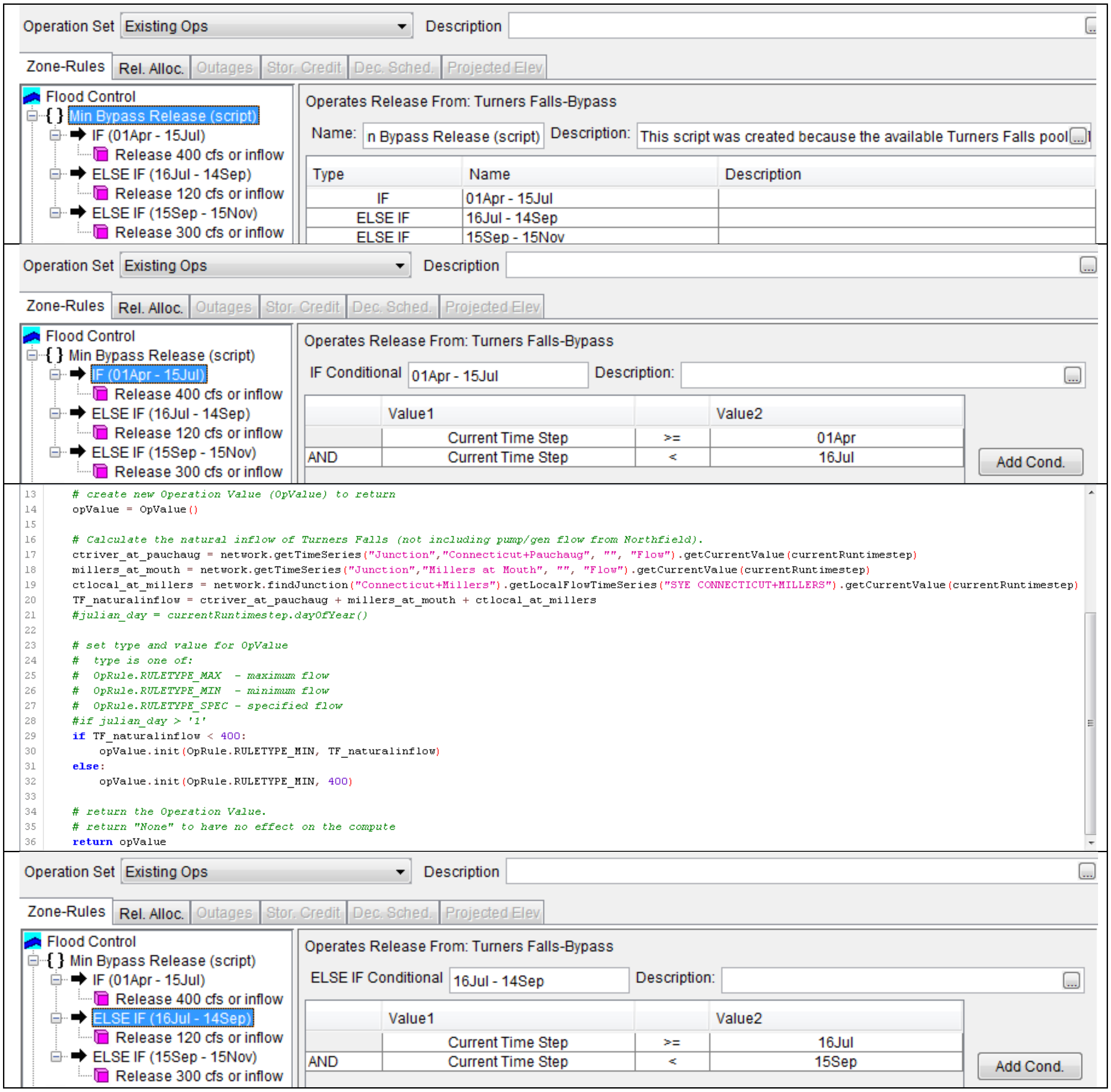


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Min Bypass Release(script)

Figure 7 shows the content of “Min Bypass Release (script)” rule. This script was created because the available Turners Falls pool inflow parameter includes generation flow from Northfield. This doesn't present too much of a problem with the current low min flow requirements because they are almost always exceeded, but could lead to issues with greater min flow requirements.



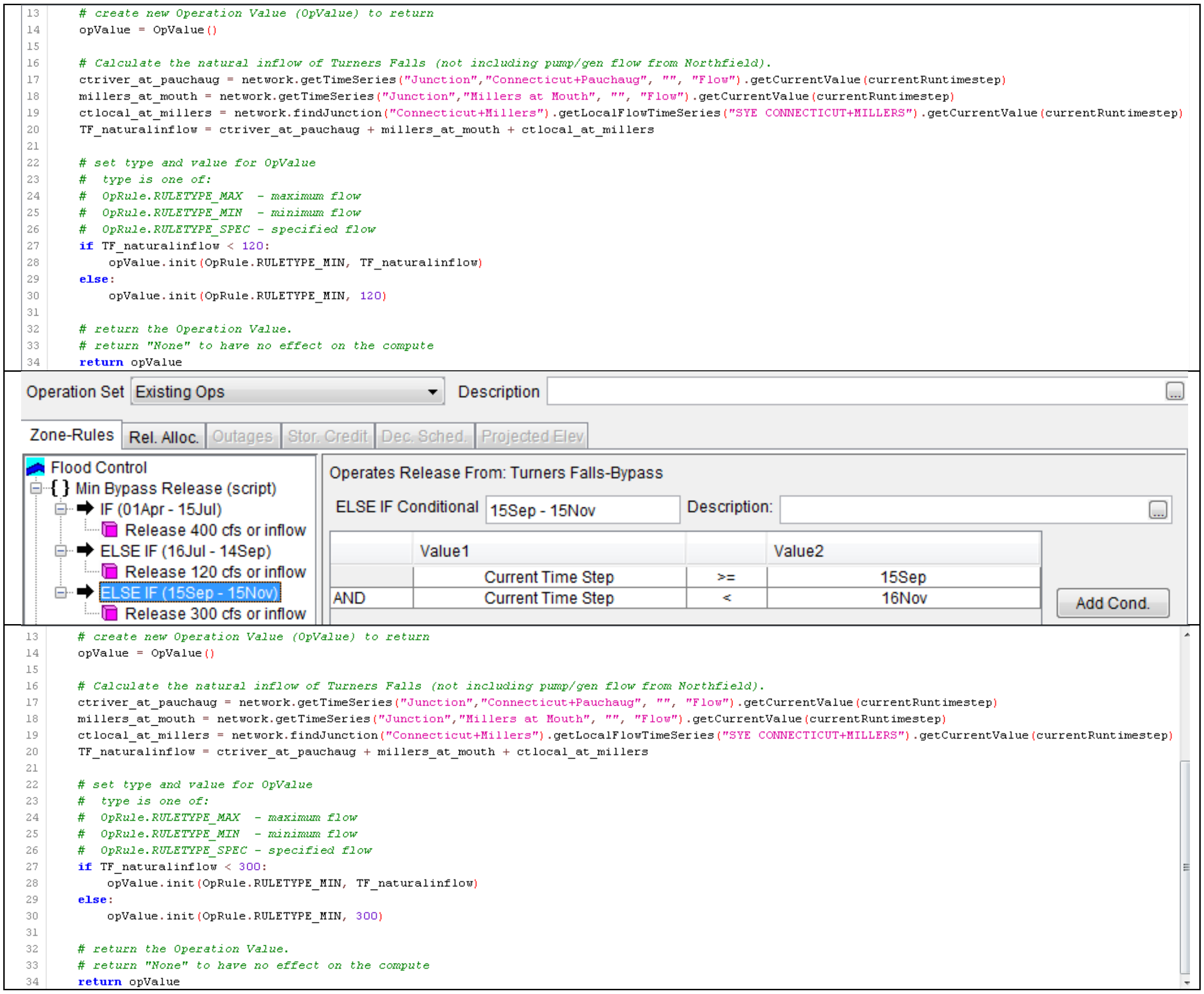


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Bypass Release (script)

2. *Min Project Release(script)*

Figure 8 shows the content of “Min Project Release (script)” rule. Release 1433 cfs or inflow, whichever is less, from the Turners Falls Project (primarily released from canal). This script was created because the available Turners Falls pool inflow parameter includes generation flow from Northfield. This doesn't present too much of a problem with a min flow of 1433 cfs because it is almost always exceeded, but could lead to issues with greater min flow requirements.

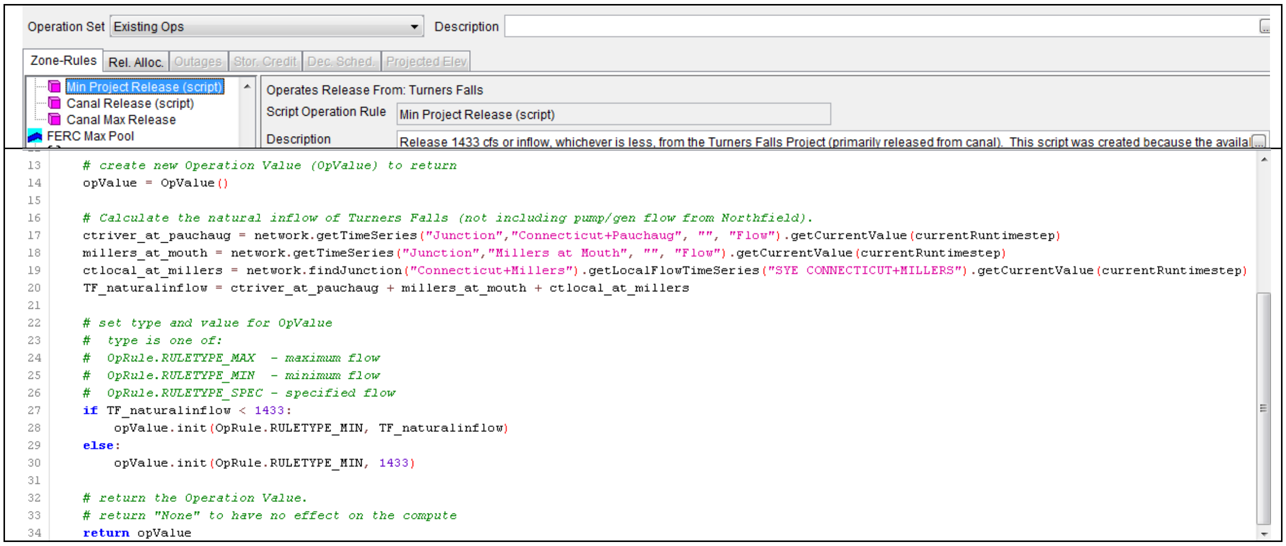


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Project Release (script)

3. Canal Release(script)

Figure 9 shows the content of “Canal release (script)” rule. When combined usable storage is < 12318 (Northfield's effective storage), only release required fishway flows to the Power Canal.

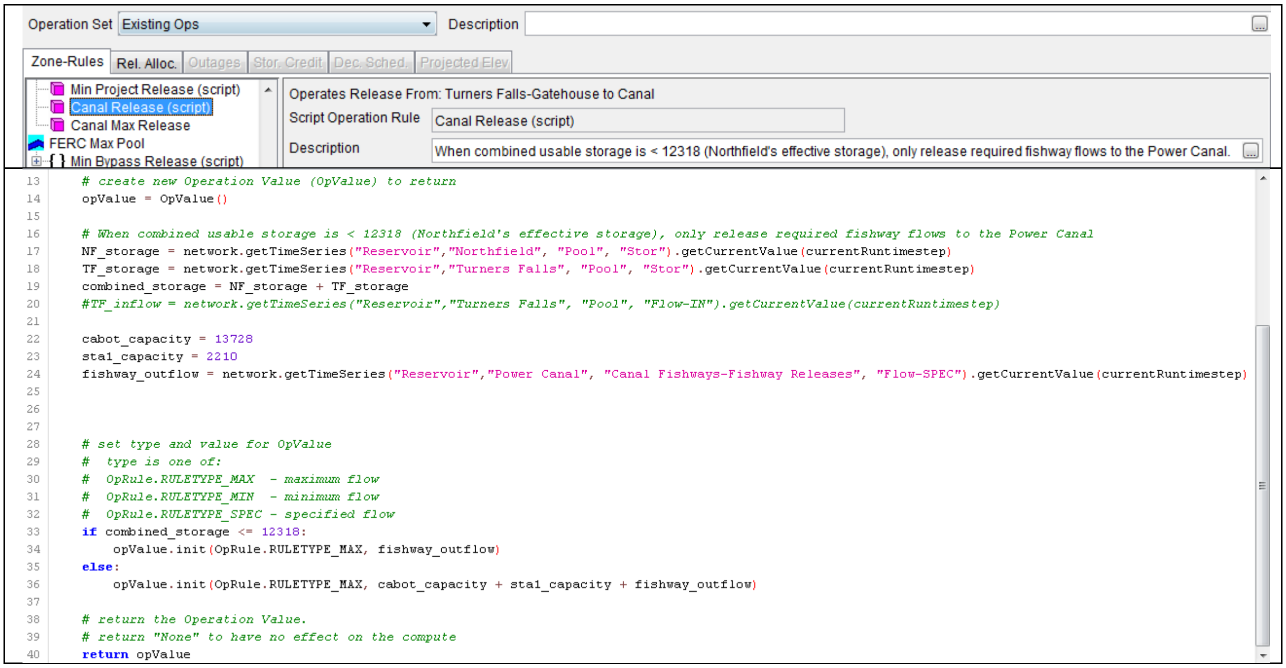


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Canal release (script)

4. Canal Max Release

Figure 10 shows the content of “Canal Max Release” rule. This rule caps the release to the canal at the capacity of Cabot + Station 1, plus any required fishway flows. It is redundant with the scripted Canal Release rule, but without this rule, the Min Project Release scripted rule somehow causes the canal to receive more flow than its current capacity, leading to spikes in the canal elevation. (The non-scripted version of the min project release rule, called Min Flow below Cabot, does not cause this problem, but its inflow parameter includes generation flow from Northfield, which could lead to issues with greater min flow requirements.)

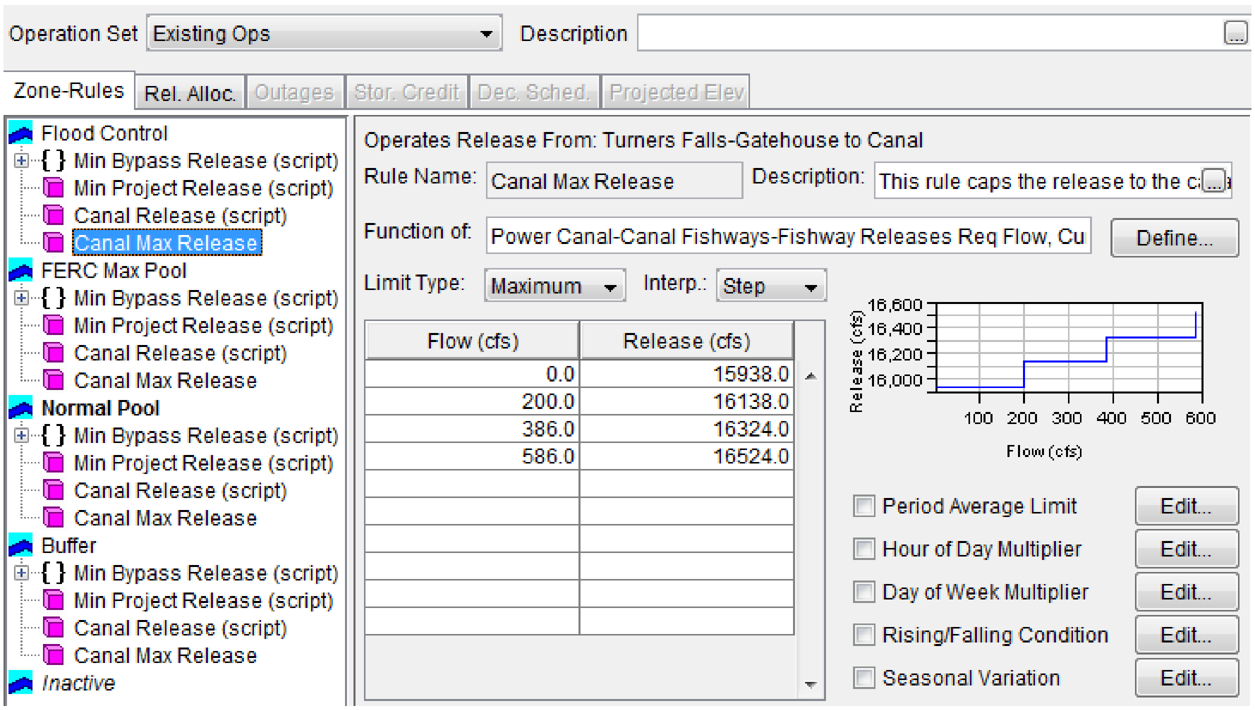


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Canal Max Release

Union Village

I. Overview

Union Village is a dam located in Thetford, Vermomt on the Ompompanuoosuc River. It was constructed in 1950 by the US Army Corps of Engineers and is still owned and operated by the Corps. It is primarily used for flood control but is also used for recreation.

Figure 1 shows the location of Union Village Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo from Union Village Dam.

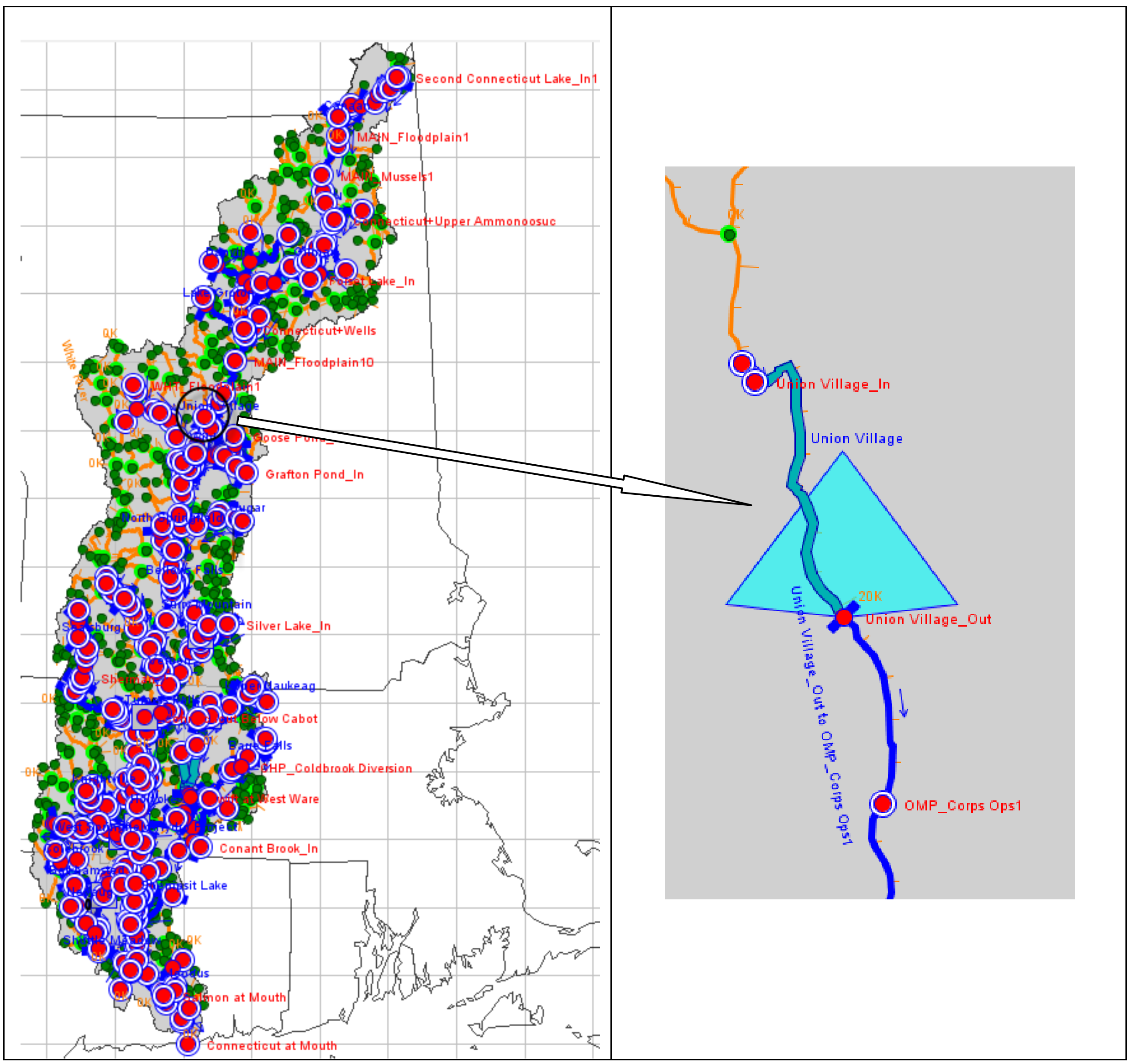


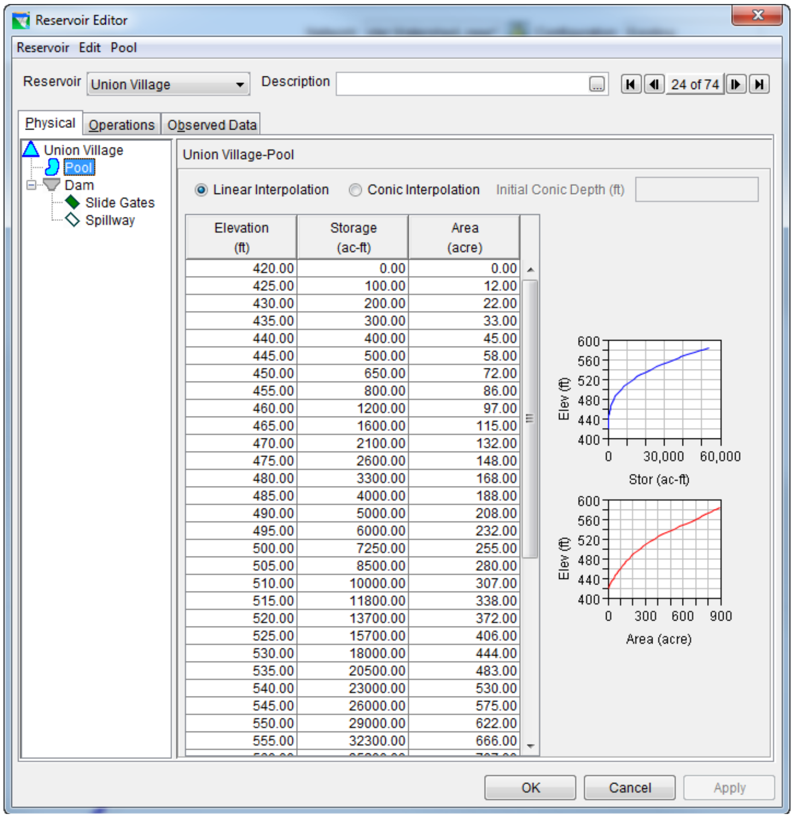
Figure 1: HEC-ResSim Map Display Showing Location of Union Village dam

Figure 2: Photo of Union Village dam.

II. Physical Characteristics

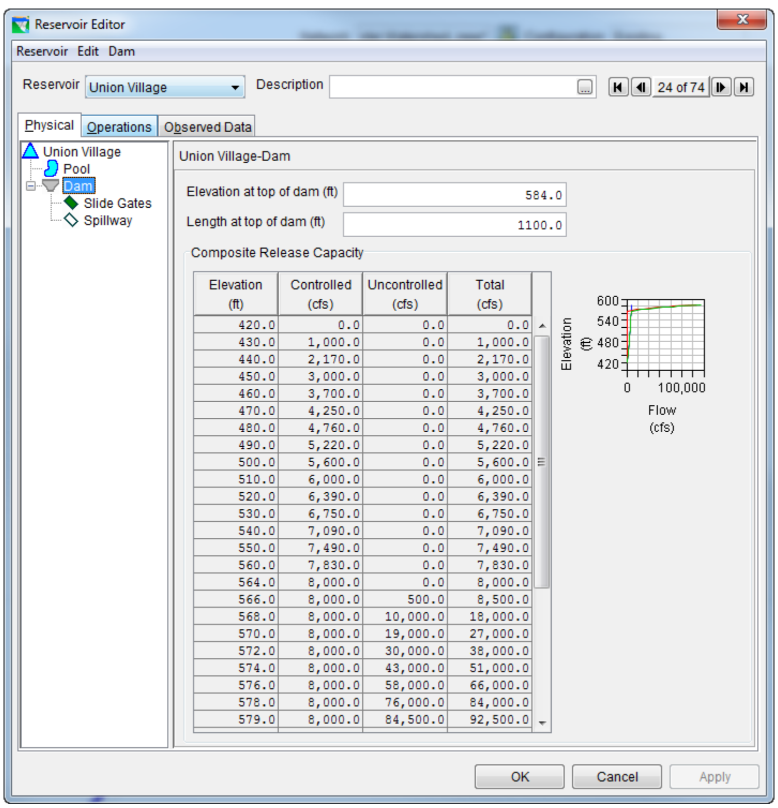
The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3. The dam consists of two types of outlets: (1) controlled Slide gates, and (2) uncontrolled Spillway, as shown in Figure 4. All physical and operations data were provided by US Army Corps New England District, through both a previously created ResSim model and the Reservoir Regulation Team website[100].

[100] http://rsgisias.crrel.usace.army.mil/nae/cwms_map.map_index



Elevation (ft)	Storage (ac-ft)	Area (acre)
420.00	0.00	0.00
425.00	100.00	12.00
430.00	200.00	22.00
435.00	300.00	33.00
440.00	400.00	45.00
445.00	500.00	58.00
450.00	650.00	72.00
455.00	800.00	86.00
460.00	1200.00	97.00
465.00	1600.00	115.00
470.00	2100.00	132.00
475.00	2600.00	148.00
480.00	3300.00	168.00
485.00	4000.00	188.00
490.00	5000.00	208.00
495.00	6000.00	232.00
500.00	7250.00	255.00
505.00	8500.00	280.00
510.00	10000.00	307.00
515.00	11800.00	338.00
520.00	13700.00	372.00
525.00	15700.00	406.00
530.00	18000.00	444.00
535.00	20500.00	483.00
540.00	23000.00	530.00
545.00	26000.00	575.00
550.00	29000.00	622.00
555.00	32300.00	666.00

Figure 3: Reservoir Editor: Physical Tab -- Pool



Elevation (ft)	Controlled (cfs)	Uncontrolled (cfs)	Total (cfs)
420.0	0.0	0.0	0.0
430.0	1,000.0	0.0	1,000.0
440.0	2,170.0	0.0	2,170.0
450.0	3,000.0	0.0	3,000.0
460.0	3,700.0	0.0	3,700.0
470.0	4,250.0	0.0	4,250.0
480.0	4,760.0	0.0	4,760.0
490.0	5,220.0	0.0	5,220.0
500.0	5,600.0	0.0	5,600.0
510.0	6,000.0	0.0	6,000.0
520.0	6,390.0	0.0	6,390.0
530.0	6,750.0	0.0	6,750.0
540.0	7,090.0	0.0	7,090.0
550.0	7,490.0	0.0	7,490.0
560.0	7,830.0	0.0	7,830.0
564.0	8,000.0	0.0	8,000.0
566.0	8,000.0	500.0	8,500.0
568.0	8,000.0	10,000.0	18,000.0
570.0	8,000.0	19,000.0	27,000.0
572.0	8,000.0	30,000.0	38,000.0
574.0	8,000.0	43,000.0	51,000.0
576.0	8,000.0	58,000.0	66,000.0
578.0	8,000.0	76,000.0	84,000.0
579.0	8,000.0	84,500.0	92,500.0

Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Union Village's "ExistingOps" operational zones, which consist of zones of Top of dam (584 ft), Flood Control (564 ft), Conservation (421-440 ft), and Inactive zone (420 ft).

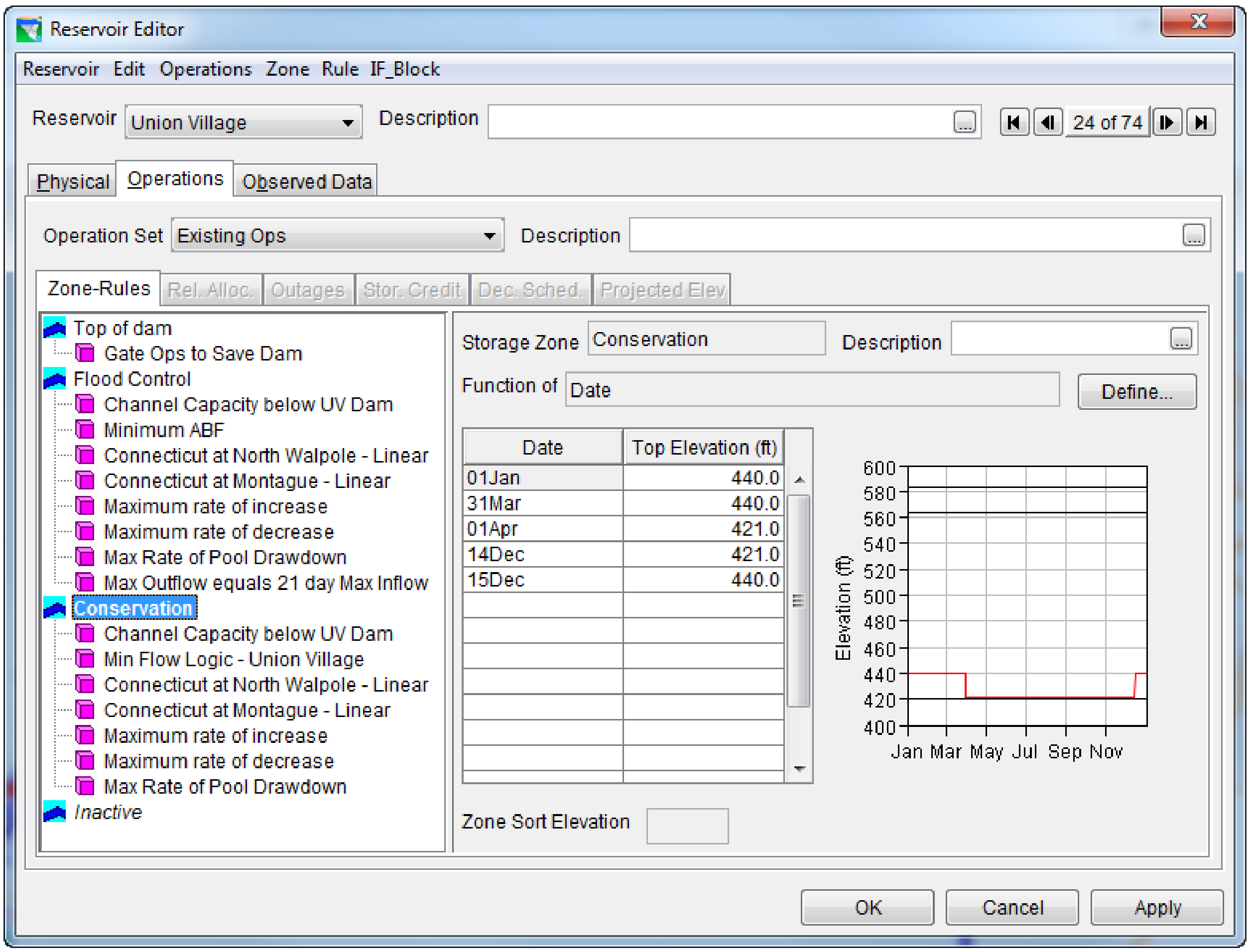


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops. As described in the Simulation/Verification section of the report, adjustments were made to the operations to closer match gauge data.

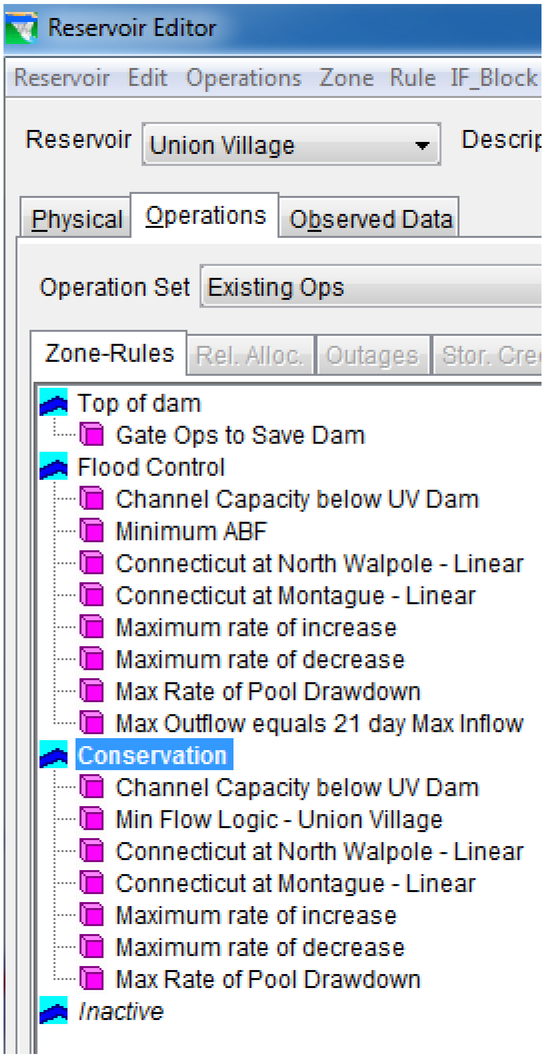


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

C. Rule Descriptions

1. Gate Ops to Save Dam

Figure 7 shows the content of “Gate ops to save Dam” rule. This rule represents the maximum allowable release from slide gates as a function of pool elevation when the pool is in Top of dam zone.

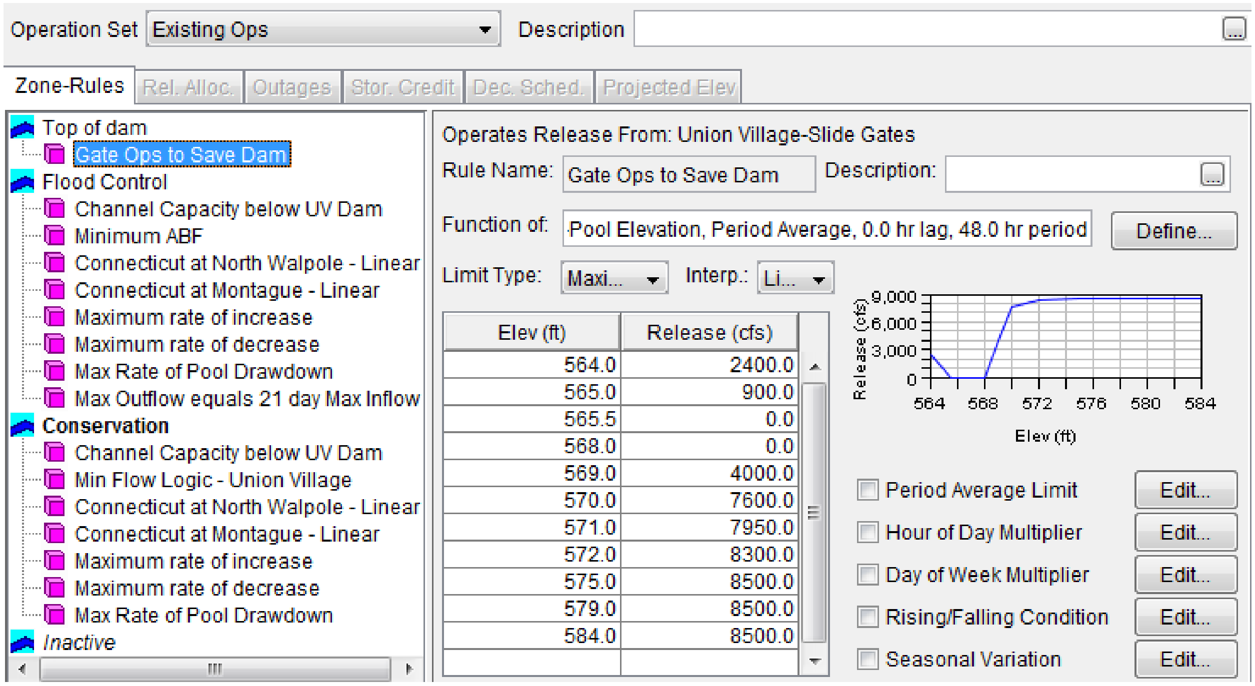


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Gate Ops to Save Dam

2. *Channel Capacity below UV Dam*

Figure 8 shows the content of "Channel Capacity below UV Dam" rule. This rule assigns 2400 cfs as the maximum allowable release from Union Village dam.

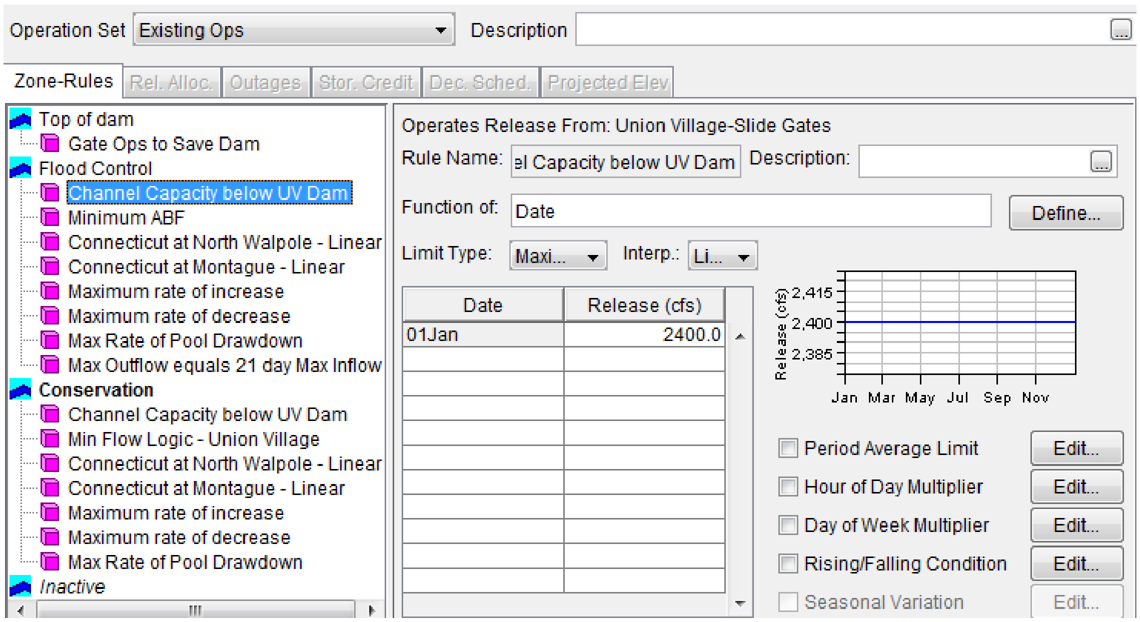


Figure 8 Reservoir Editor: Operations Tab – Existing Ops OpSet – Channel Capacity below UV Dam

3. *Minimum ABF*

Figure 9 shows the content of "Minimum ABF" rule. This rule provides the minimum required release from dam when pool is in flood control zone.

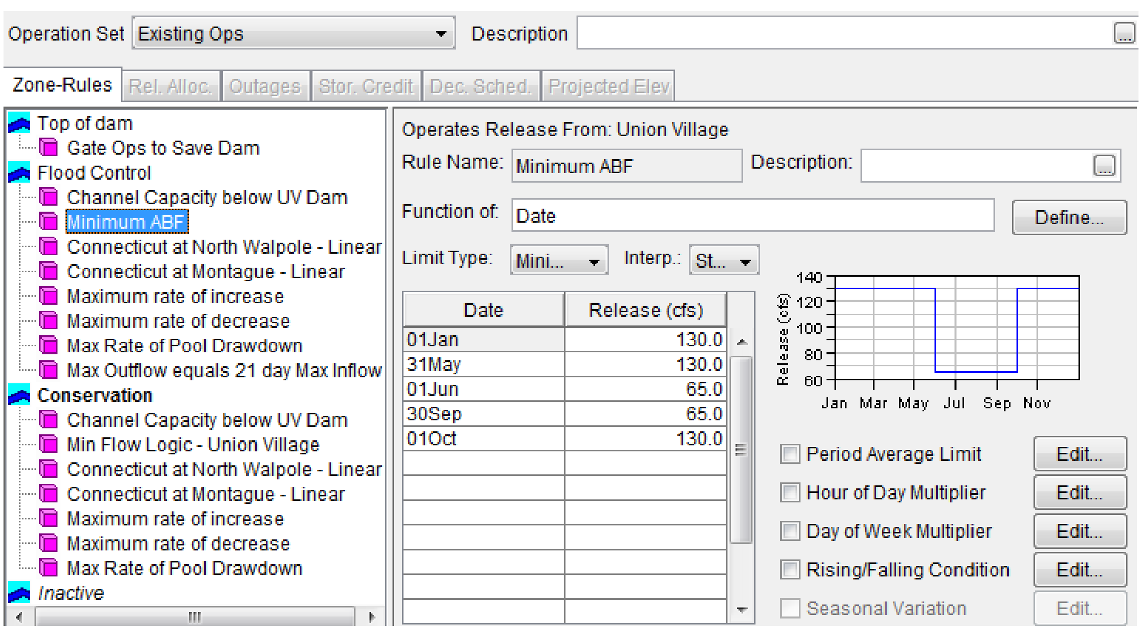


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Minimum ABF

4. Connecticut at North Walpole-Linear

Figure 10: shows the content of "Connecticut at North Walpole-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at North Walpole. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

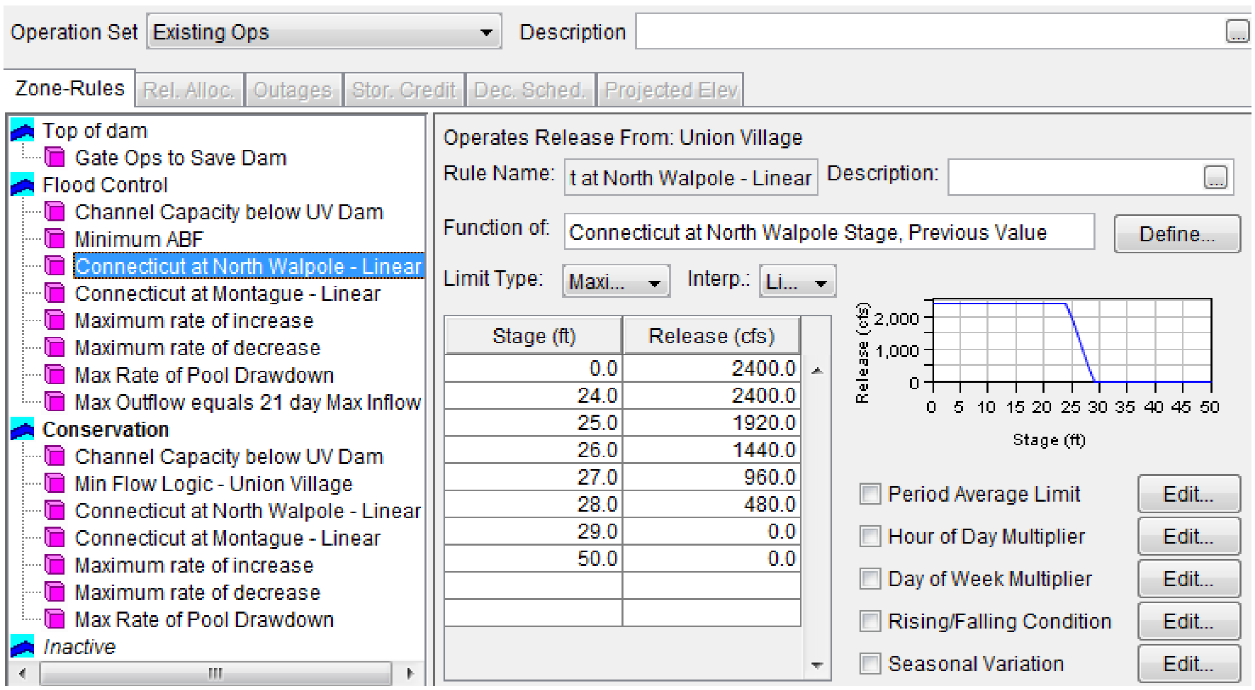


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at North Walpole-Linear

5. *Connecticut at Montague-Linear*

Figure 11 shows the content of "Connecticut at Montague-Linear" rule. This rule represents the maximum allowable release from the dam as a function of the previous day stage at Montague. The previous day stage was used to account for the delay that occurs between the stage exceeding the specified target and the change in operations at the flood control dams that occurs in reality.

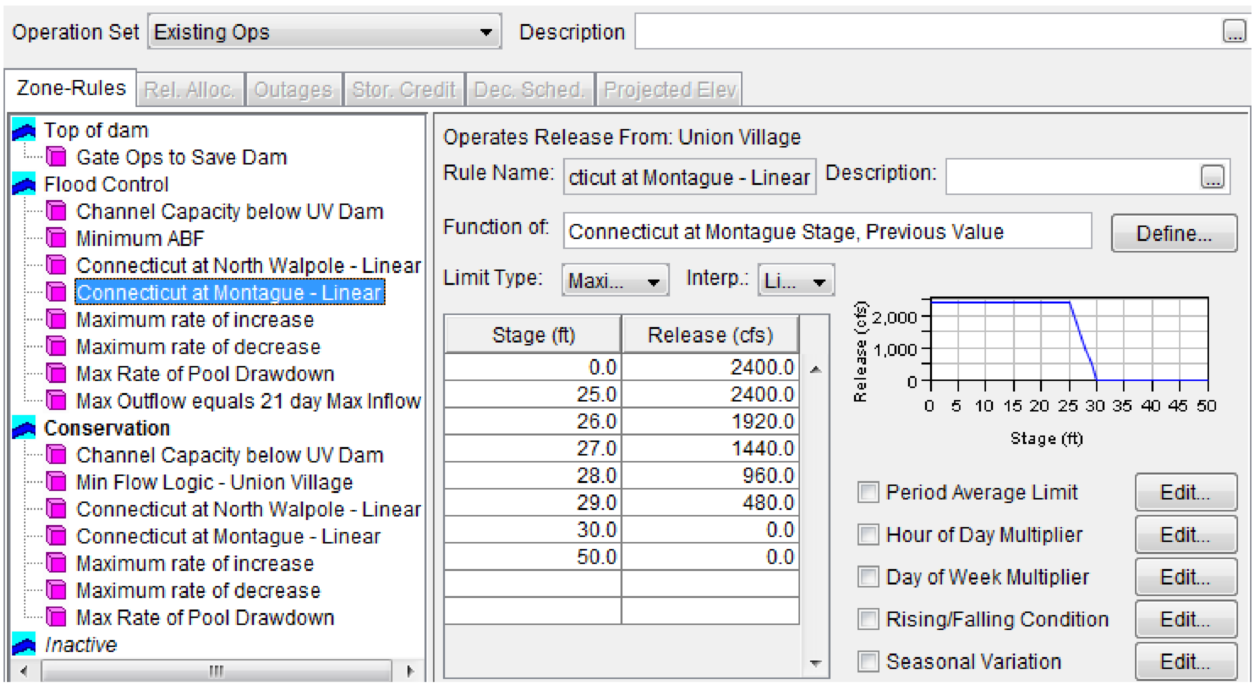


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Connecticut at Montague-Linear

6. *Maximum rate of increase*

Figure 12 shows the content of “Maximum rate of increase” rule. This rule shows the maximum allowable increasing release rate of change as a function of release from Union Village dam.

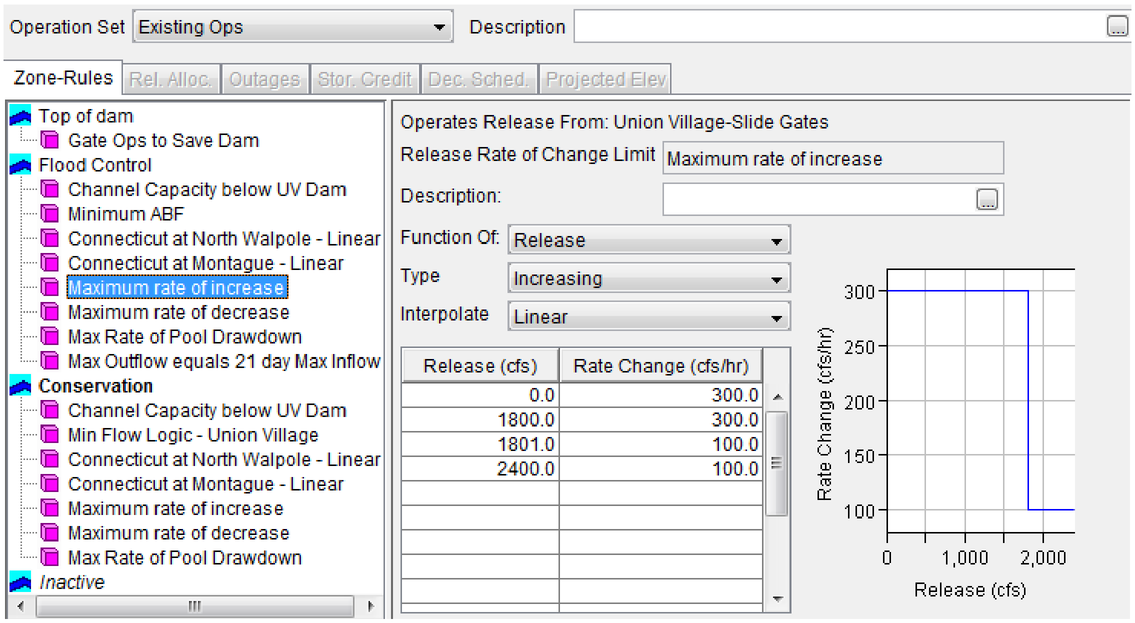


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maximum rate of increase

7. *Maximum rate of decrease*

Figure 13 shows the content of “Maximum rate of decrease” rule. This rule shows the maximum allowable decreasing release rate of change.

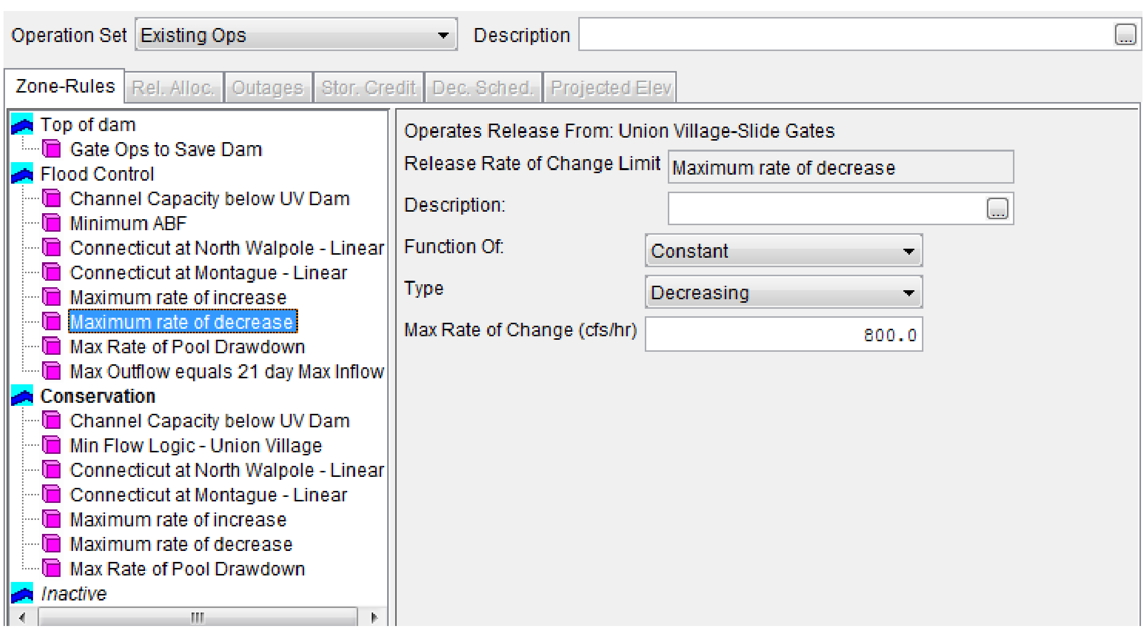


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Maximum rate of decrease

8. *Max Rate of pool Drawdown*

Figure 13 shows the content of "Max Rate of pool Drawdown" rule. This rule shows the maximum allowable decreasing pool elevation rate of change.

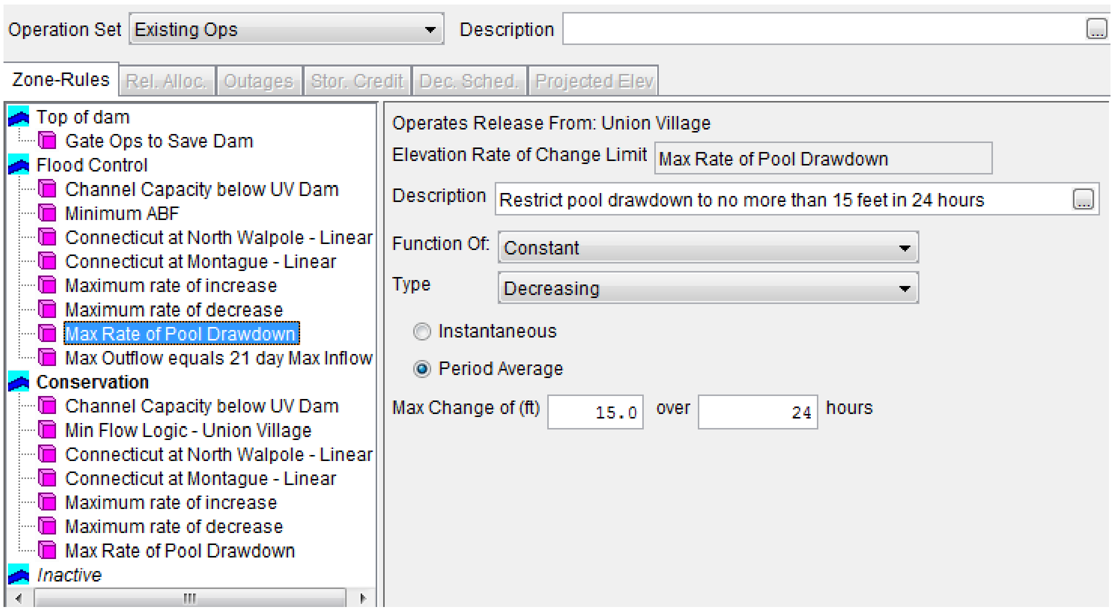


Figure 13 Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Rate of pool Drawdown

9. *Max Outflow equals 21 day Max Inflow*

Figure 14 shows the content of "Max Outflow equals 21 day Max Inflow" rule. This rule represents the maximum release from dam as a function of the previous 3 weeks of inflow.

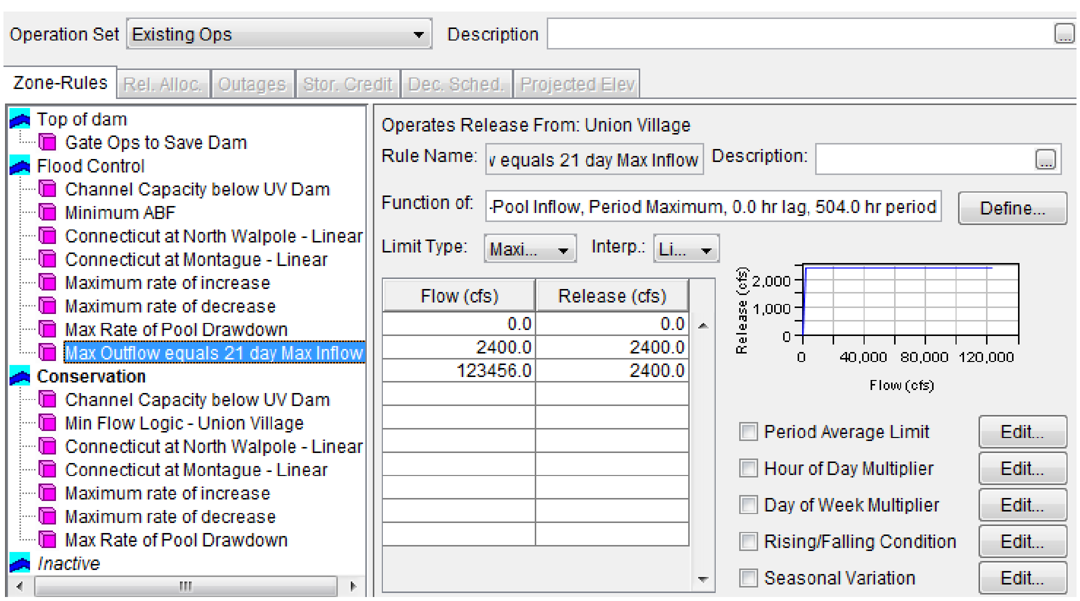


Figure 14 Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Outflow equals 21 day Max Inflow

10. Min Flow Logic-Union Village

Figure 15 shows the content of “Min Flow Logic-Union Village” rule. This rule describes seasonal minimum flows from dam as a function of inflow at Union Village.

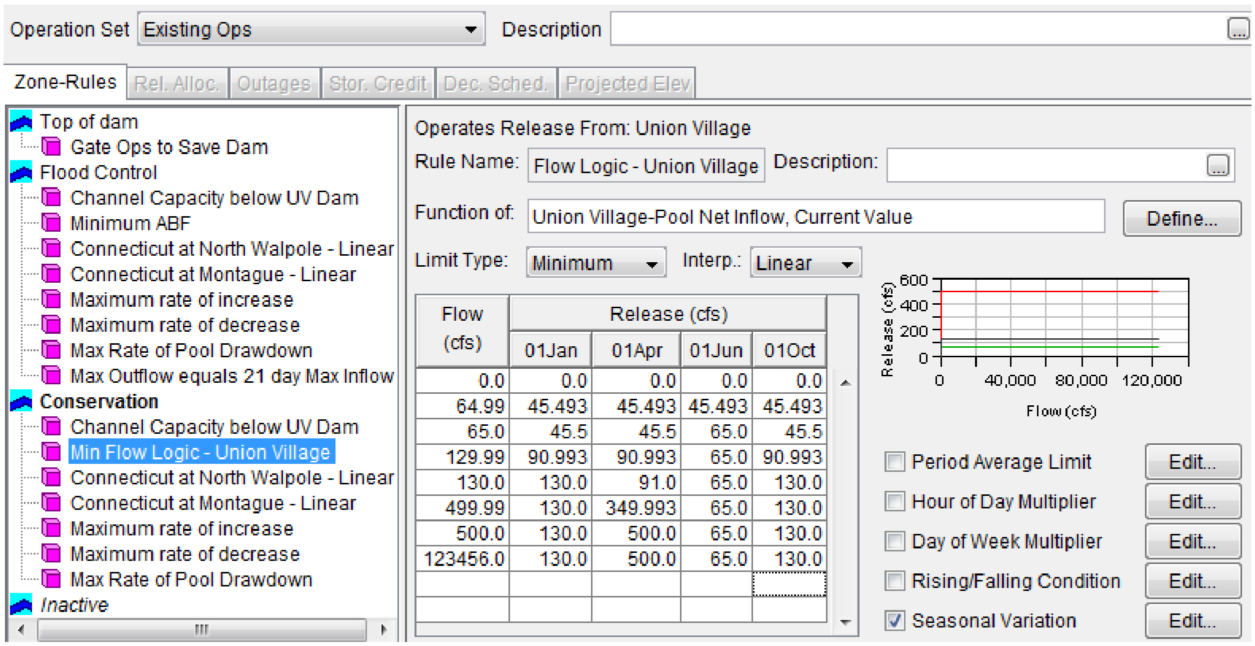


Figure 15 Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow Logic-Union Village

Upper Naukeag

I. Overview

Upper Naukeag dam is located by the towns of Winchendon and Ashburnham, MA and feeds into the Millers River. The dam is owned and operated by the towns of Winchendon and Ashburnham and is used for water supply for the two towns.

Figure 1 shows the location of Upper Naukeag Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Upper Naukeag Lake.

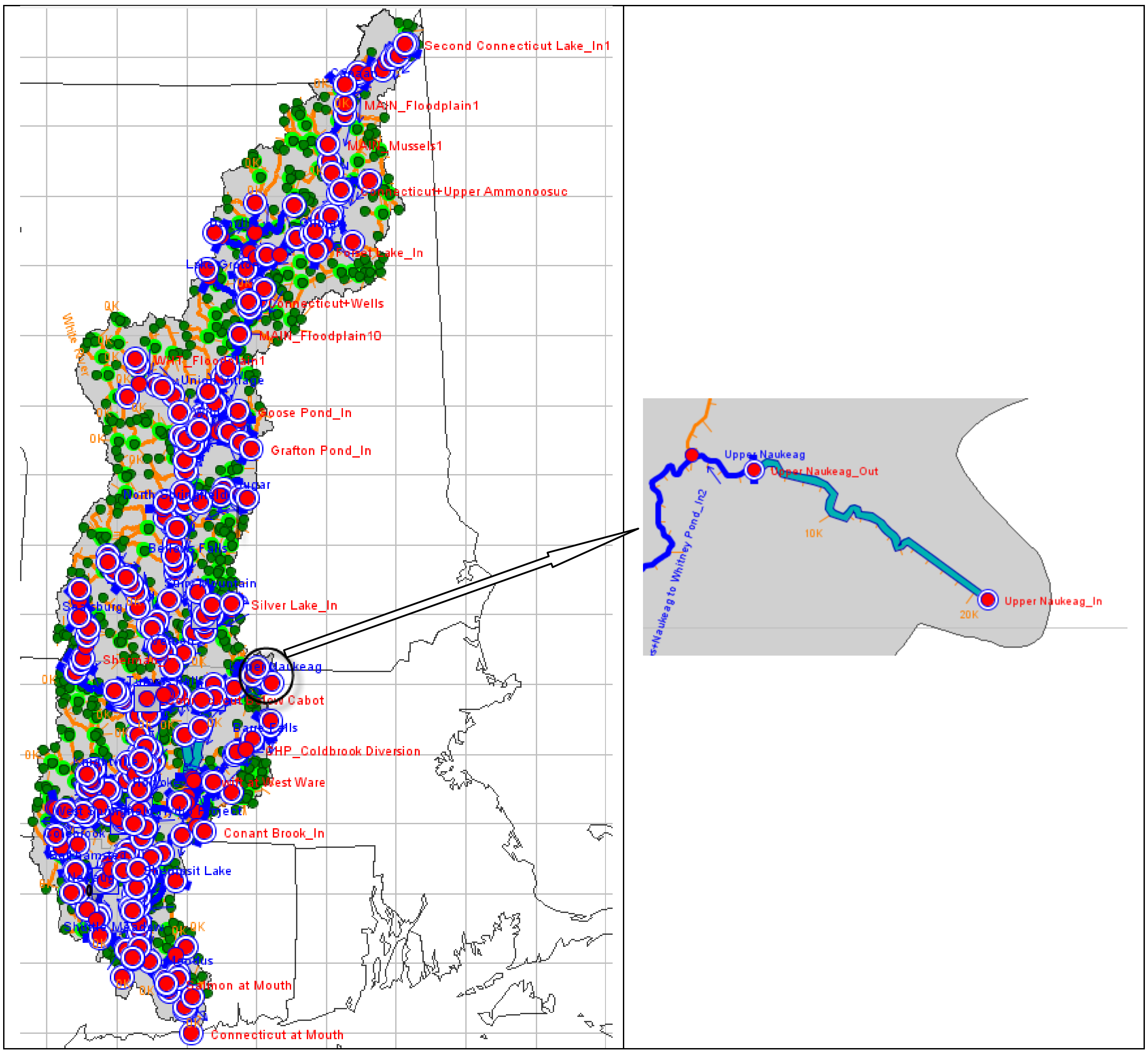


Figure 1: HEC-ResSim Map Display Showing Location of Upper Naukeag Dam

Figure 2: Photo of Upper Naukeag Lake.

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[101]. The dam consists of an uncontrolled outlet as shown in Figure 4.

[101] National Inventory of Dams database.

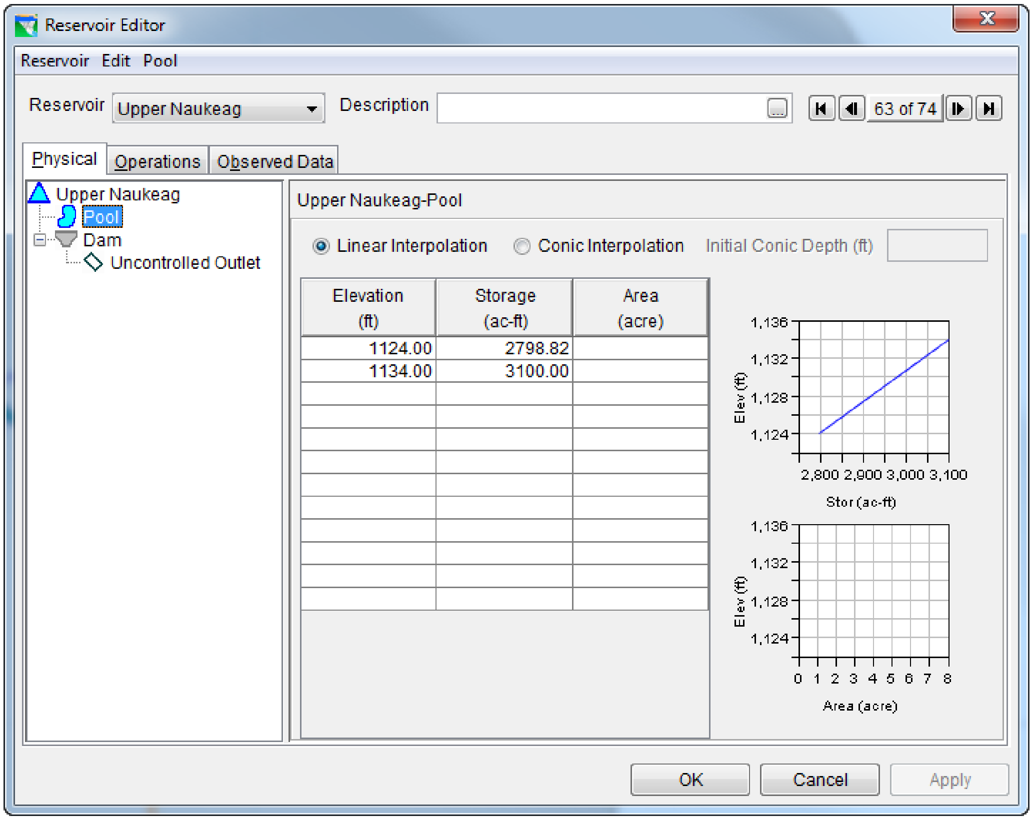


Figure 3: Reservoir Editor: Physical Tab -- Pool

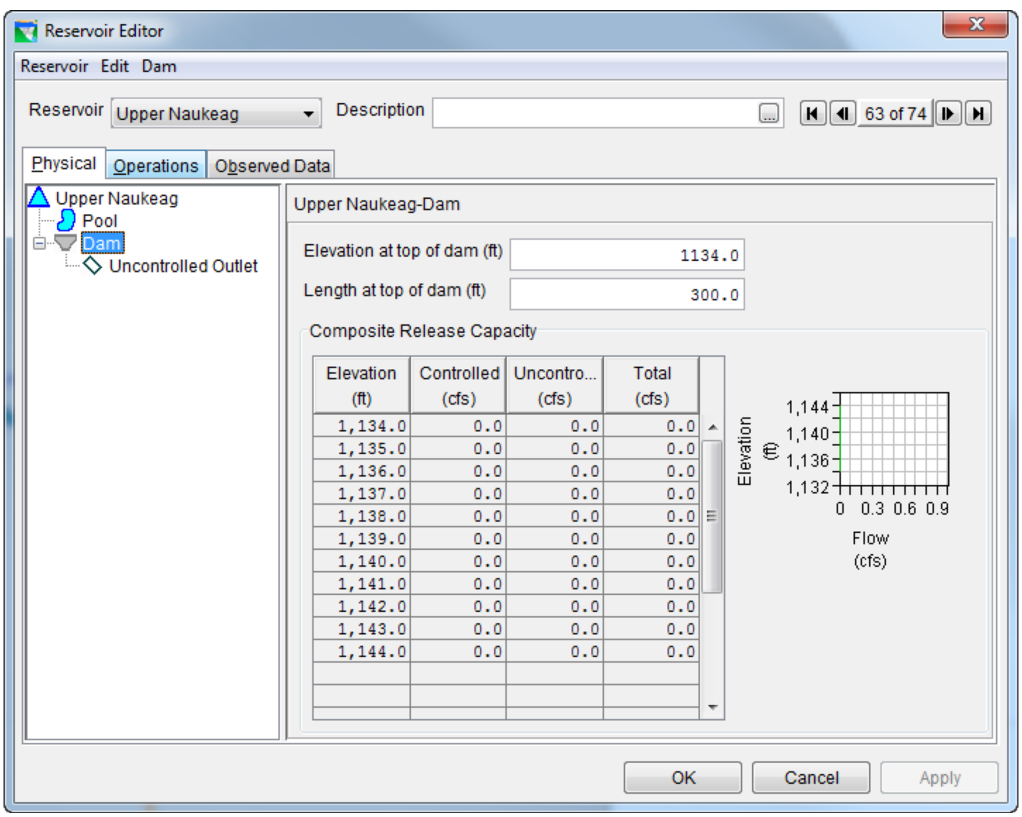


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Upper Naukeag Dam's "Guide Curve" operational zones, which consist of zones of Flood Control (1134 ft), Conservation (1133 ft), and Inactive zone (1126 ft)[102].

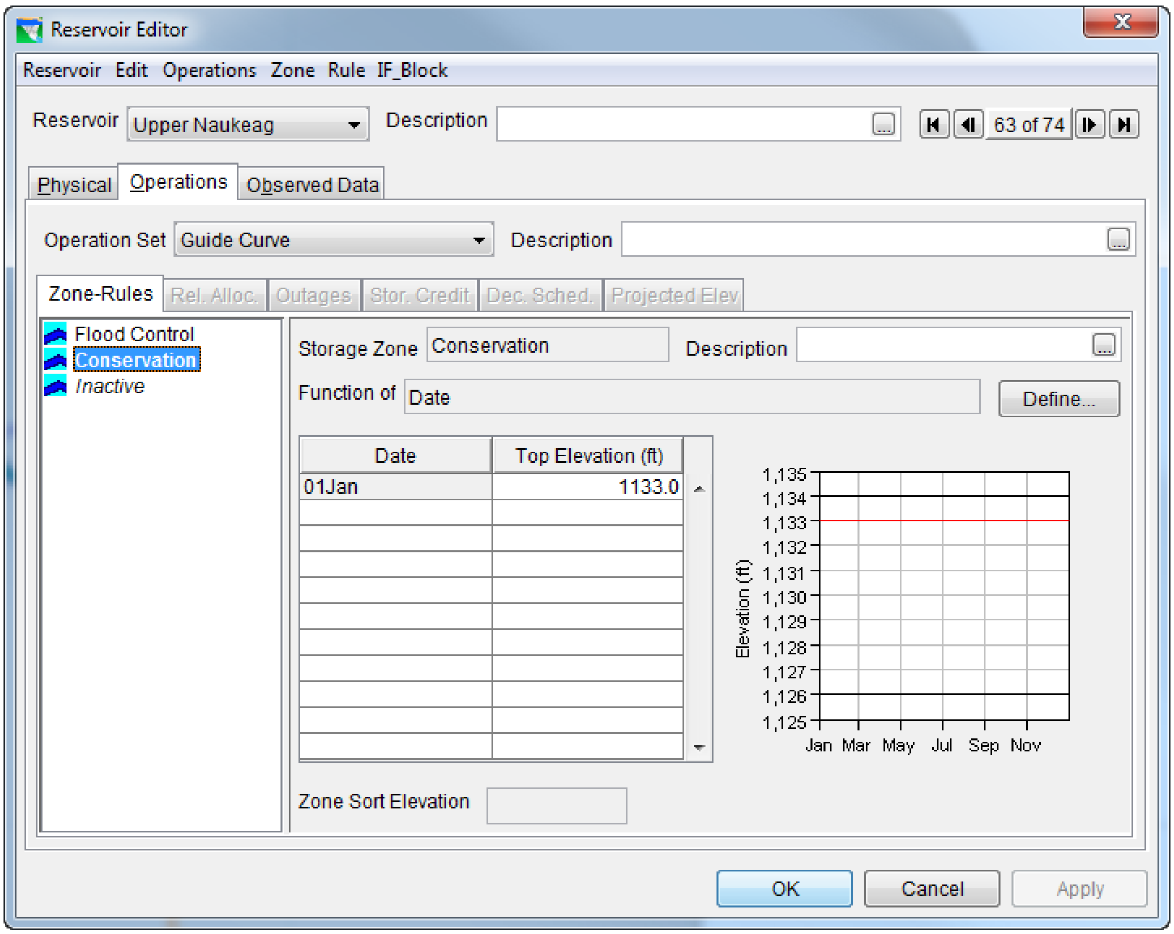


Figure 5 Reservoir Editor: Operations Tab – Guide Curve OpSet

B. Rule Illustrations

The operation set for Upper Naukeag Dam has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacit

[102] Water supply records

Vernon

I. Overview

Vernon is located on the Connecticut River in the towns of Vernon, VT and Hinsdale, NH. It is owned and operated by TransCanada Hydro Northeast Inc. for hydropower generation on a run-of-river basis.

Figure 1 shows the location of Vernon dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Vernon dam.

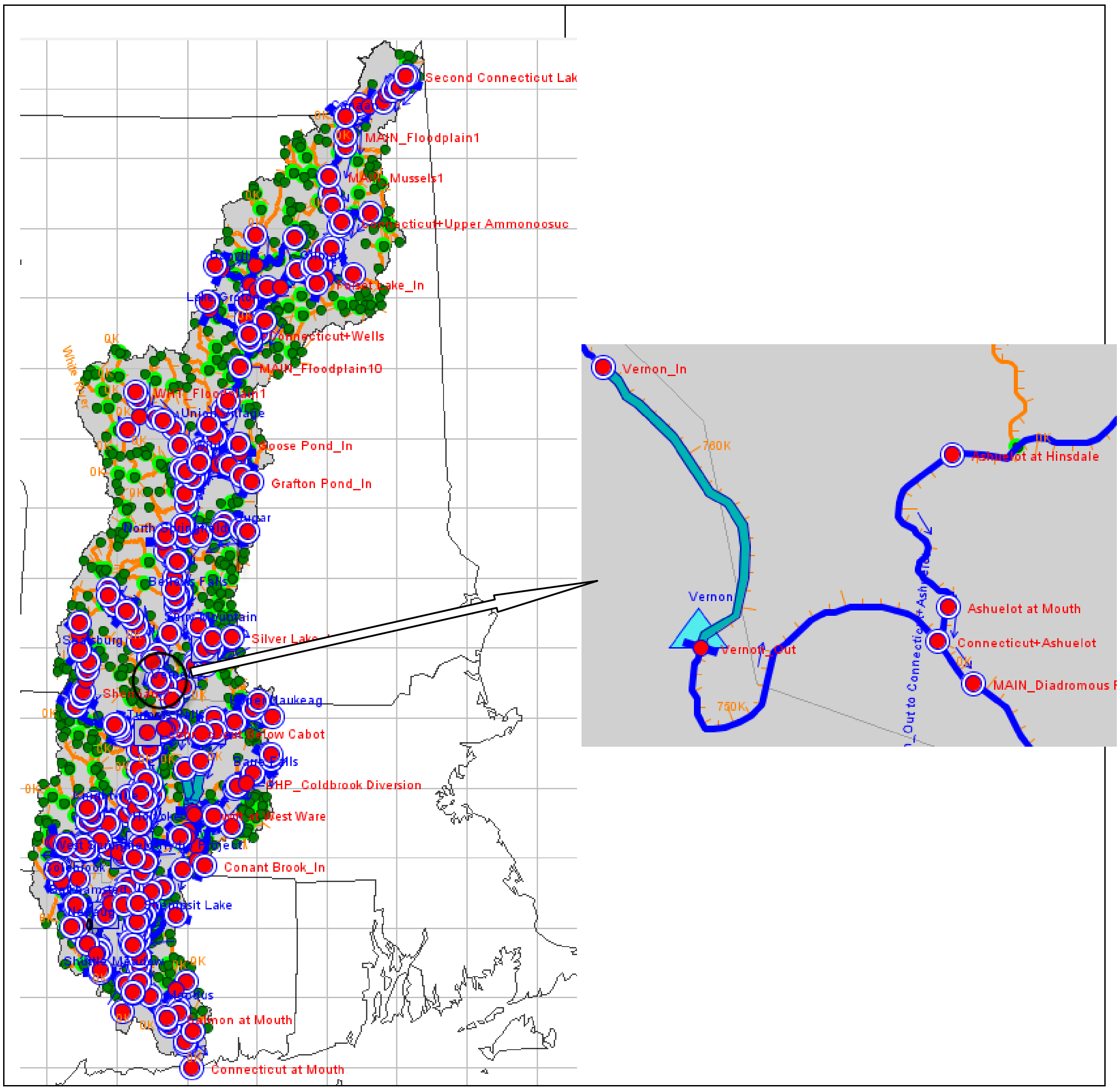


Figure 1: HEC-ResSim Map Display Showing Location of Vernon dam

Figure 2: Photo of Vernon dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[103]. The dam consists of nine types of outlets: (1) controlled Trash sluice gates, (2) controlled Tainter gates-10*50, (3) controlled Tainter Gates-20*50, (4) controlled sluice flood gate, (5) controlled Fish ladder, (6) uncontrolled stanchion 42.5 ft- W flashboards, (7) uncontrolled stanchion 50 ft-W flashboards, (8) controlled Fish Pipe+Fish Tube , and (9) power plant as shown in Figure 4.

[103] Data provided by TransCanada

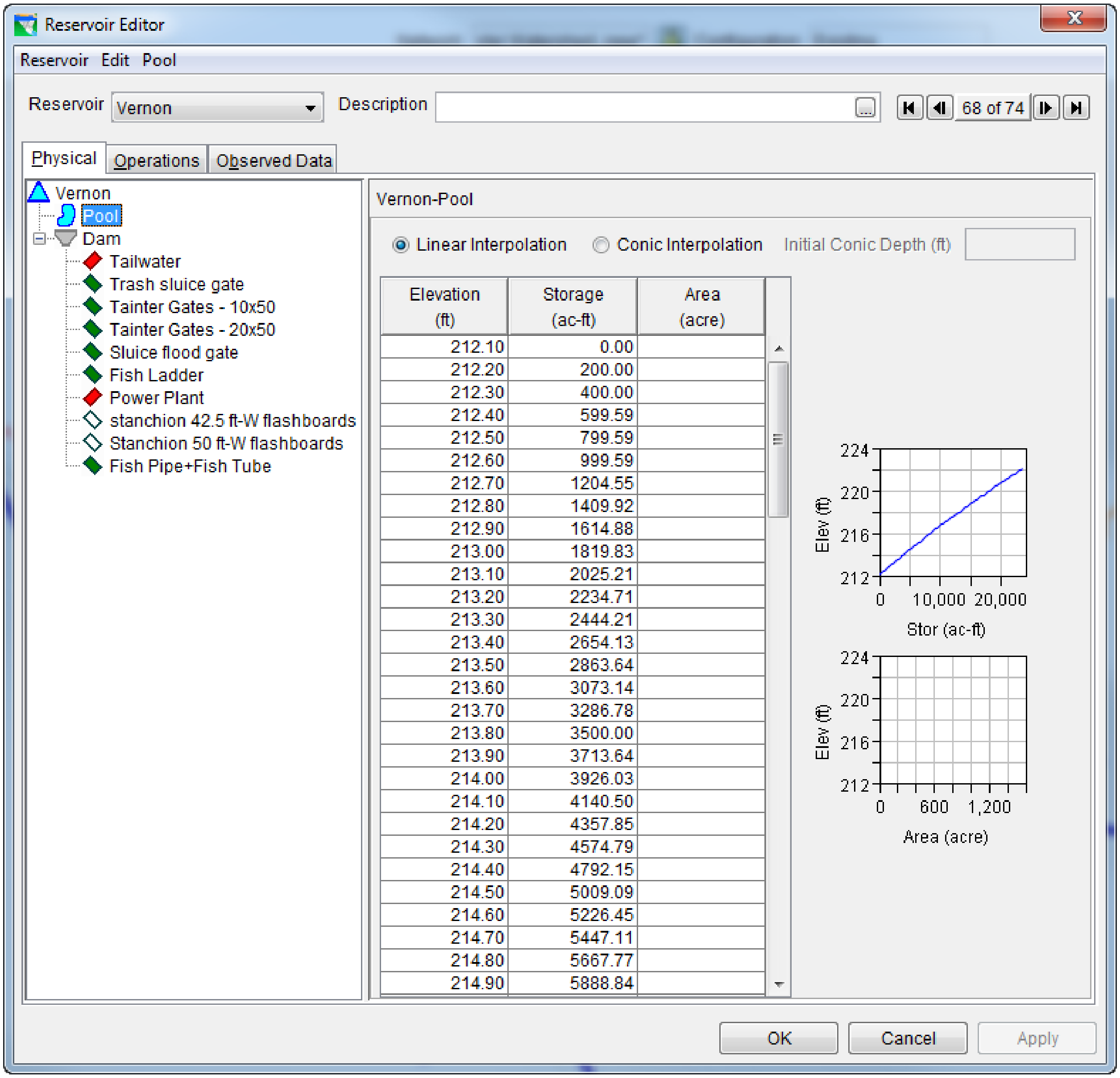


Figure 3: Reservoir Editor: Physical Tab -- Pool

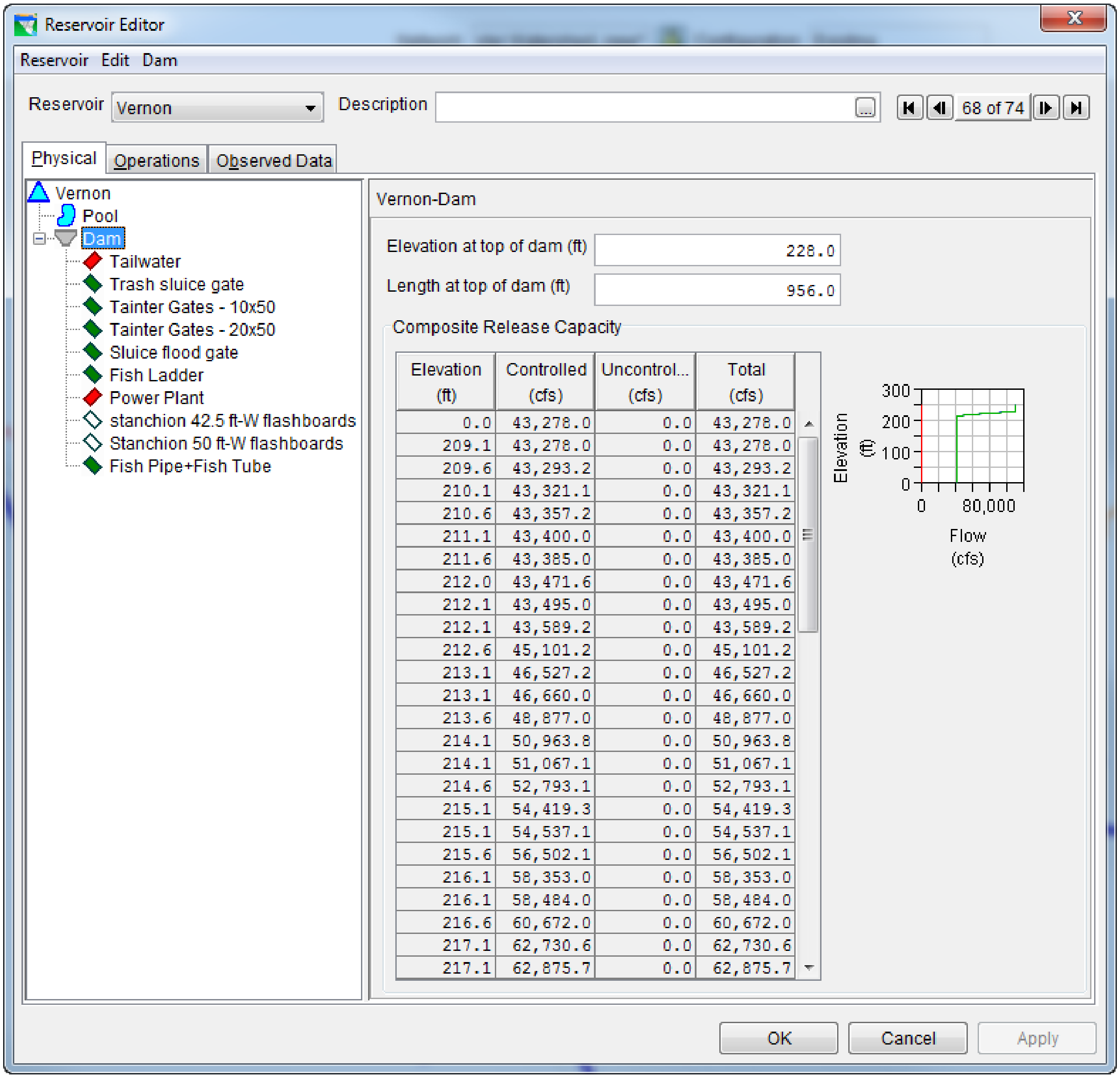


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Vernon's "ExistingOps" operational zones, which consist of zones of Flood Control (228 ft), Normal high pool (220 ft), Conservation (219.8 ft), Buffer (218.6 ft), and Inactive zone (212 ft)[1].

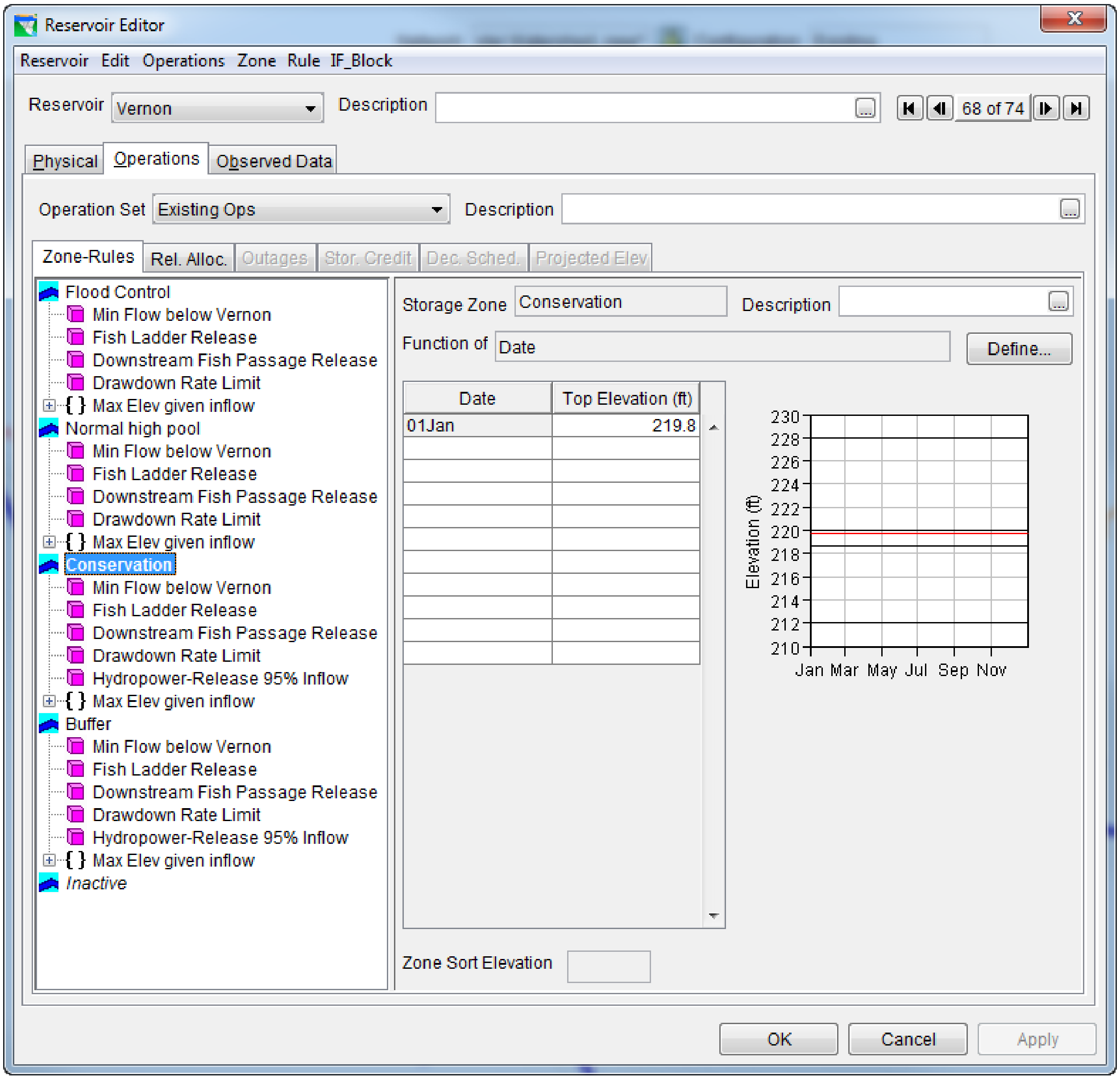


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[104].

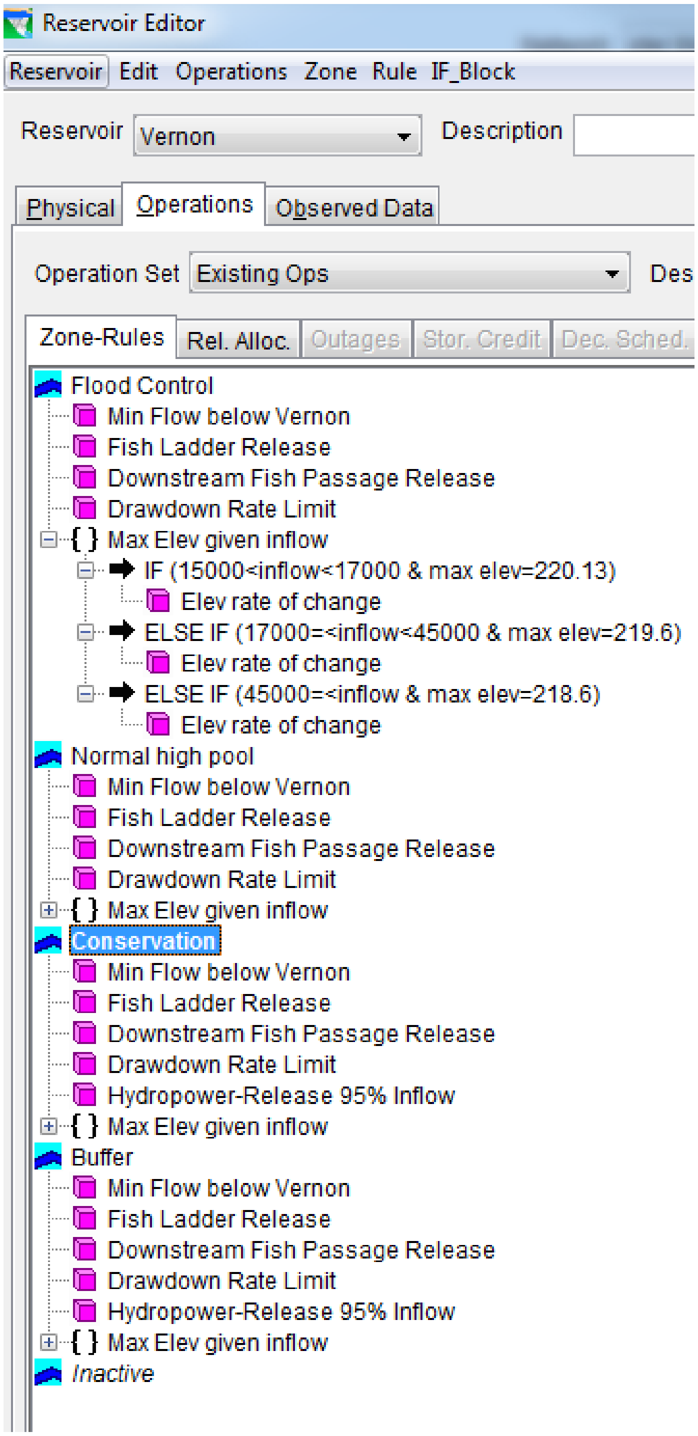


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[104] TransCanada. Connecticut River Operational Constraints. 2012.

Figure 7 shows a sequential release allocation approach specified for available outlets along Bellows Falls Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The Trash sluice gate gets the remainder of the release until it reaches capacity. The flow passes through Tainter Gates-10*50 and then Tainter Gates-20*50. The next priority is assigned to sluice flood gate. After the capacity through the sluice flood gate is reached, the remainder of the release goes through the Fish pipe+Fish Tube and Fish Ladder, respectively.

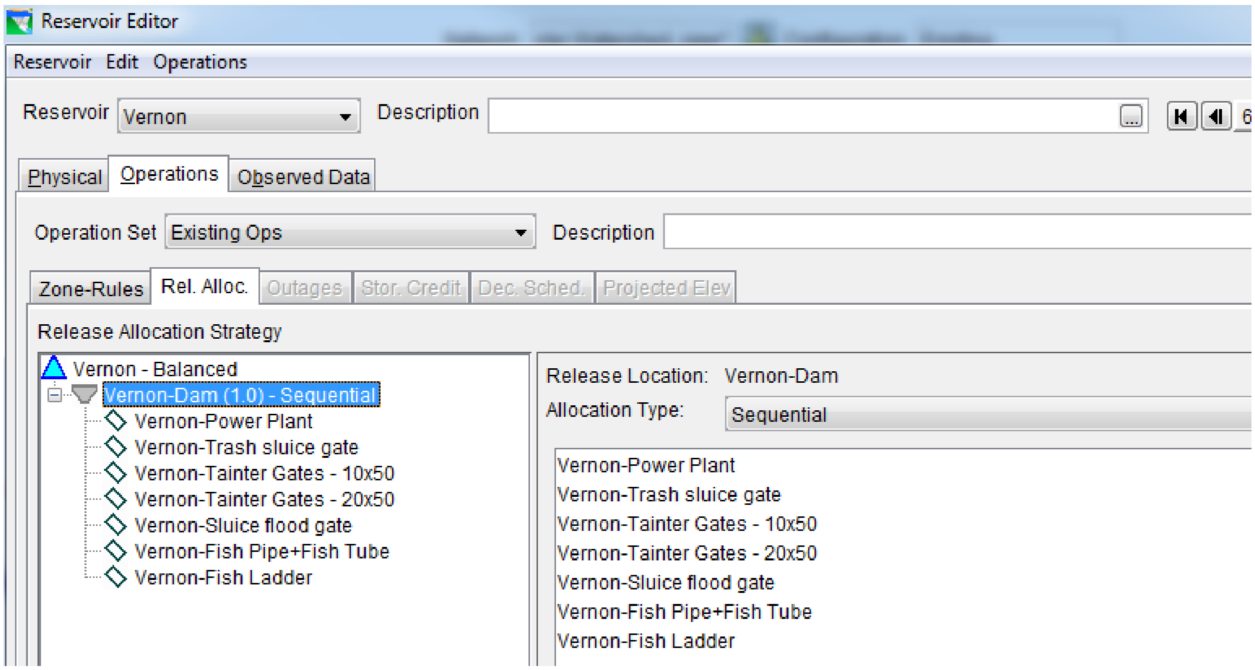


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

C. Rule Descriptions

1. Min Flow below Vernon

Figure 8 shows the content of “Min flow below Vernon” rule. This rule shows a minimum release from dam as a function of Inflow.

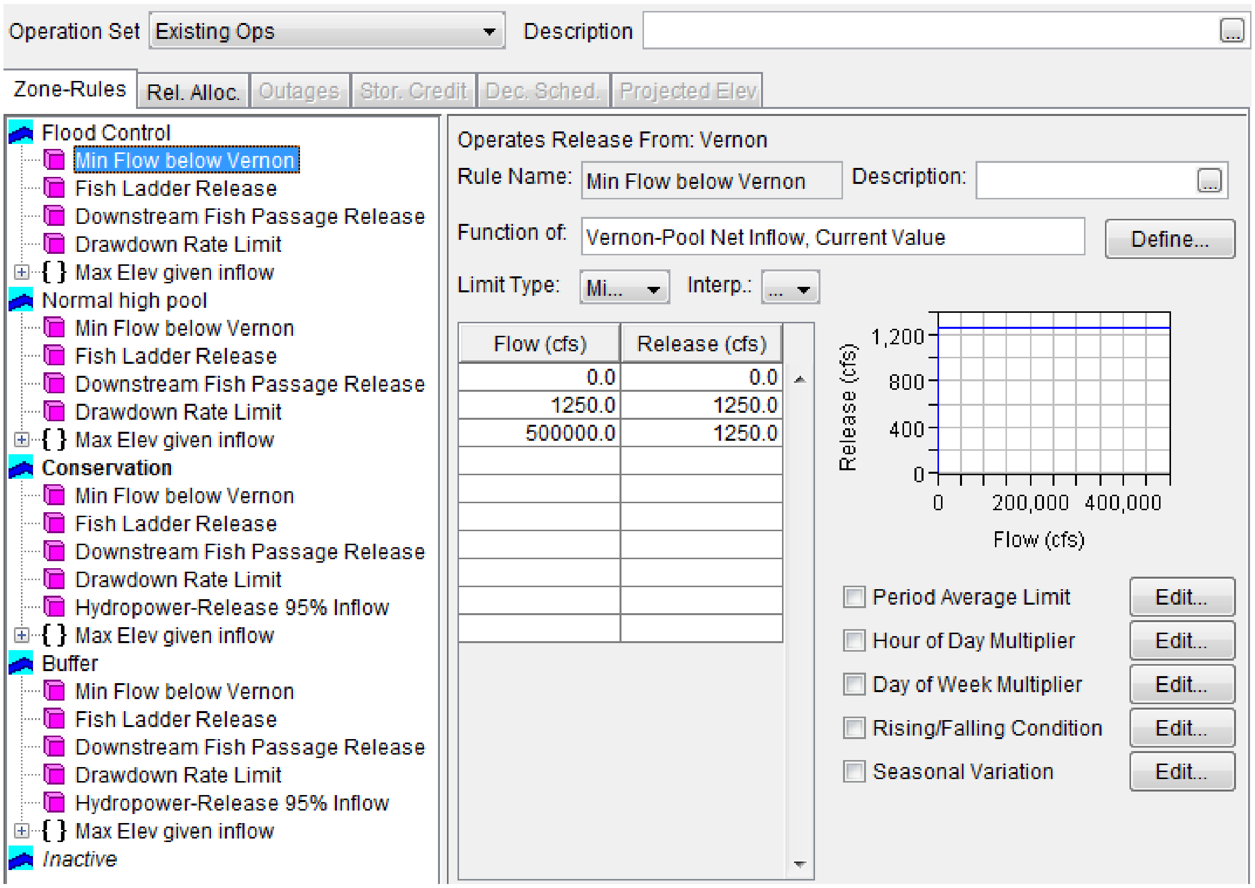


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow below Vernon

2. *Fish Ladder Release*

Figure 9 shows the content of "Fish Ladder Release" rule. This rule shows the specified release from Fish Ladder gate.

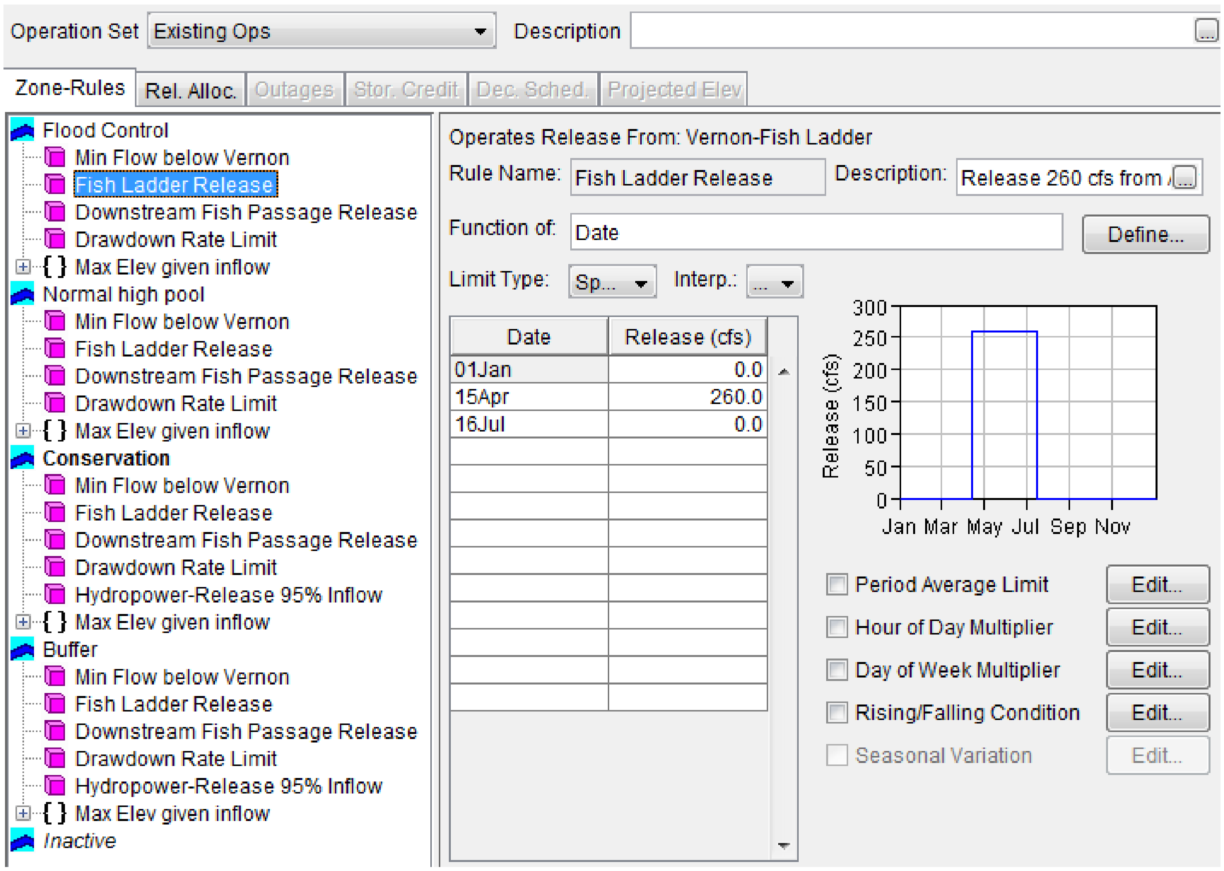


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Fish Ladder Release

3. *Downstream Fish Passage Release*

Figure 10 shows the content of "Downstream Fish Passage Release" rule. This rule shows the specified release from Fish pipe + Fish Tube gate.

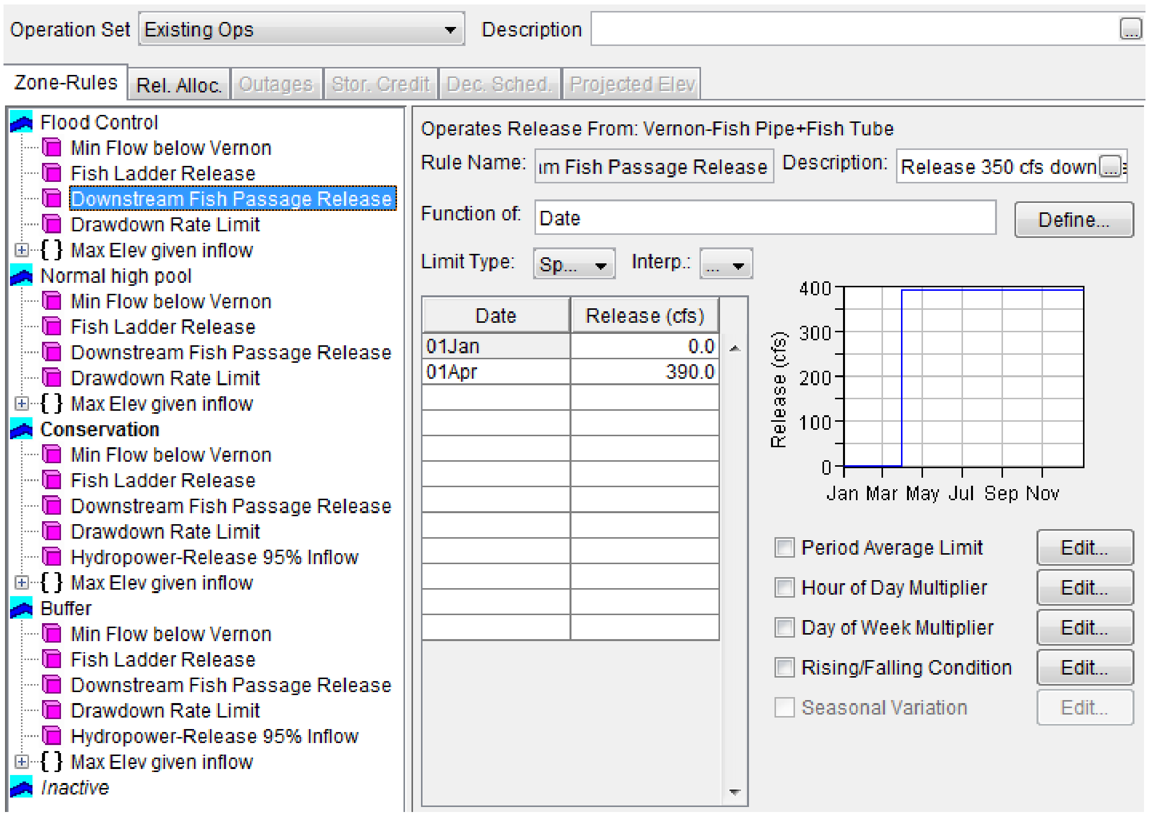


Figure 10 Reservoir Editor: Operations Tab – Existing Ops OpSet – Downstream Fish Passage Release

4. *Drawdown Rate Limit*

Figure 11 shows the content of “Drawdown Rate Limit” rule. This rule shows the decreasing elevation rate of change rule.

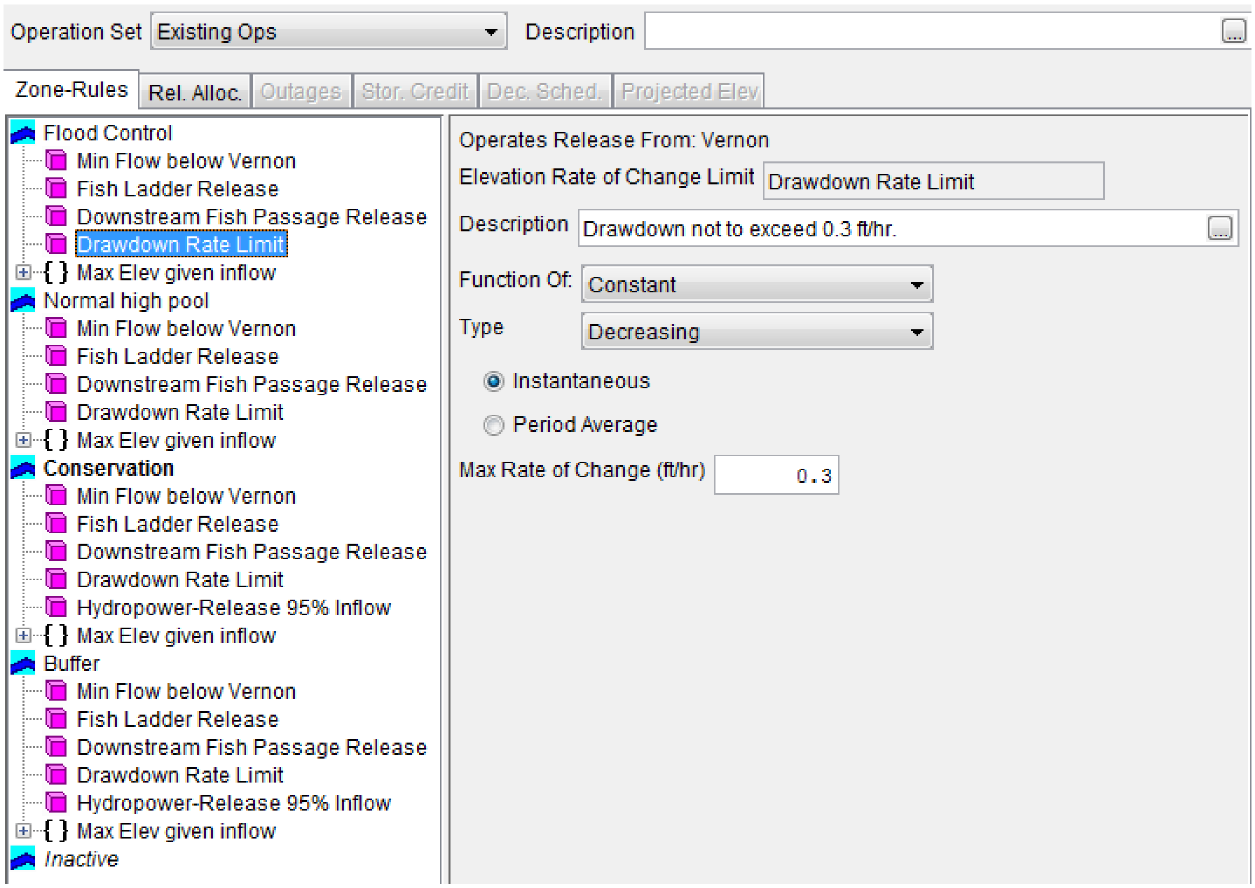
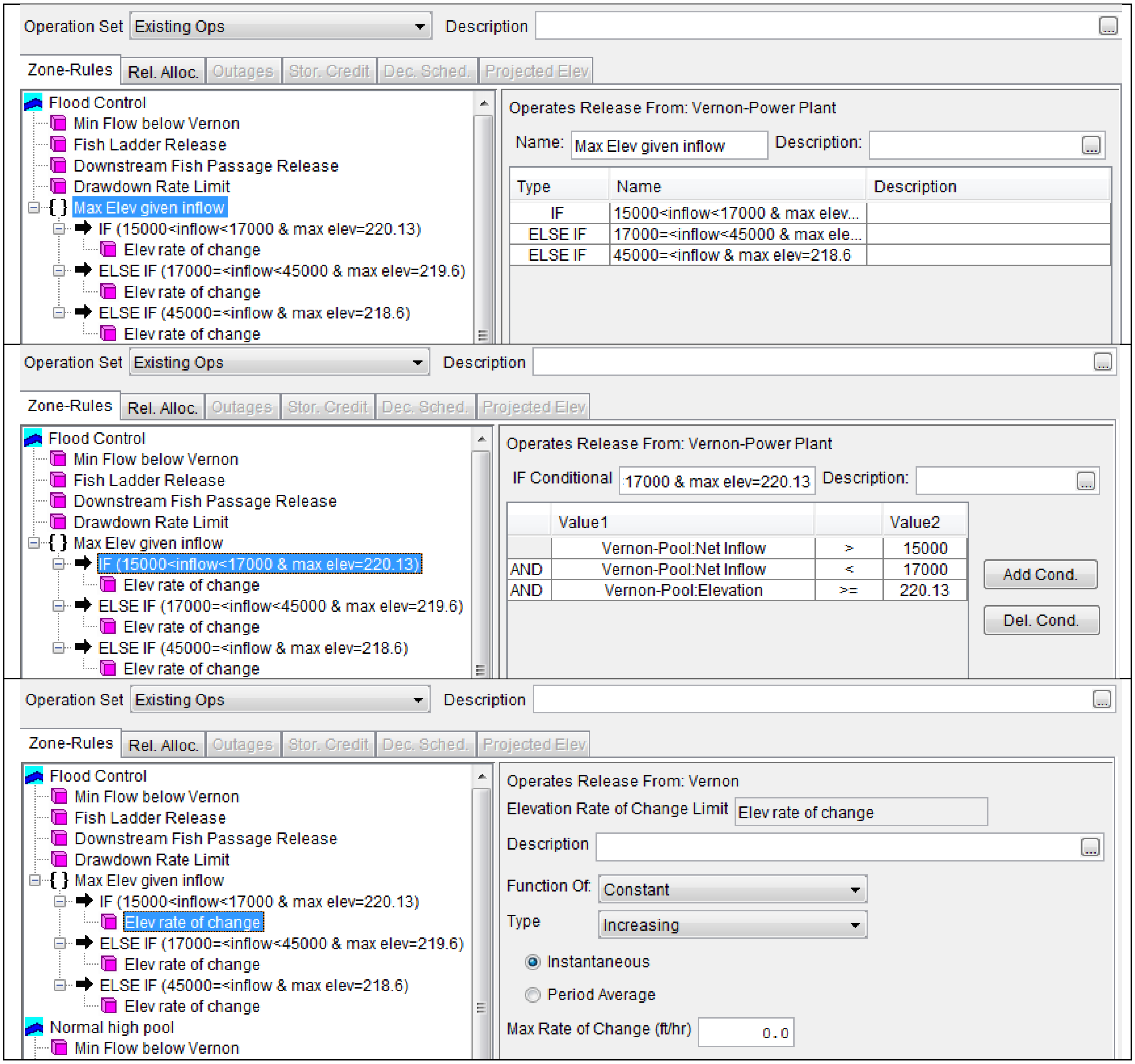


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Drawdown Rate Limit

5. *Max Elev given inflow*

Figure 12 shows the content of “Max Elev given inflow” rule. For each combination of Inflow and maximum pool elevation shown in the below picture the maximum elevation rate of change equals zero.



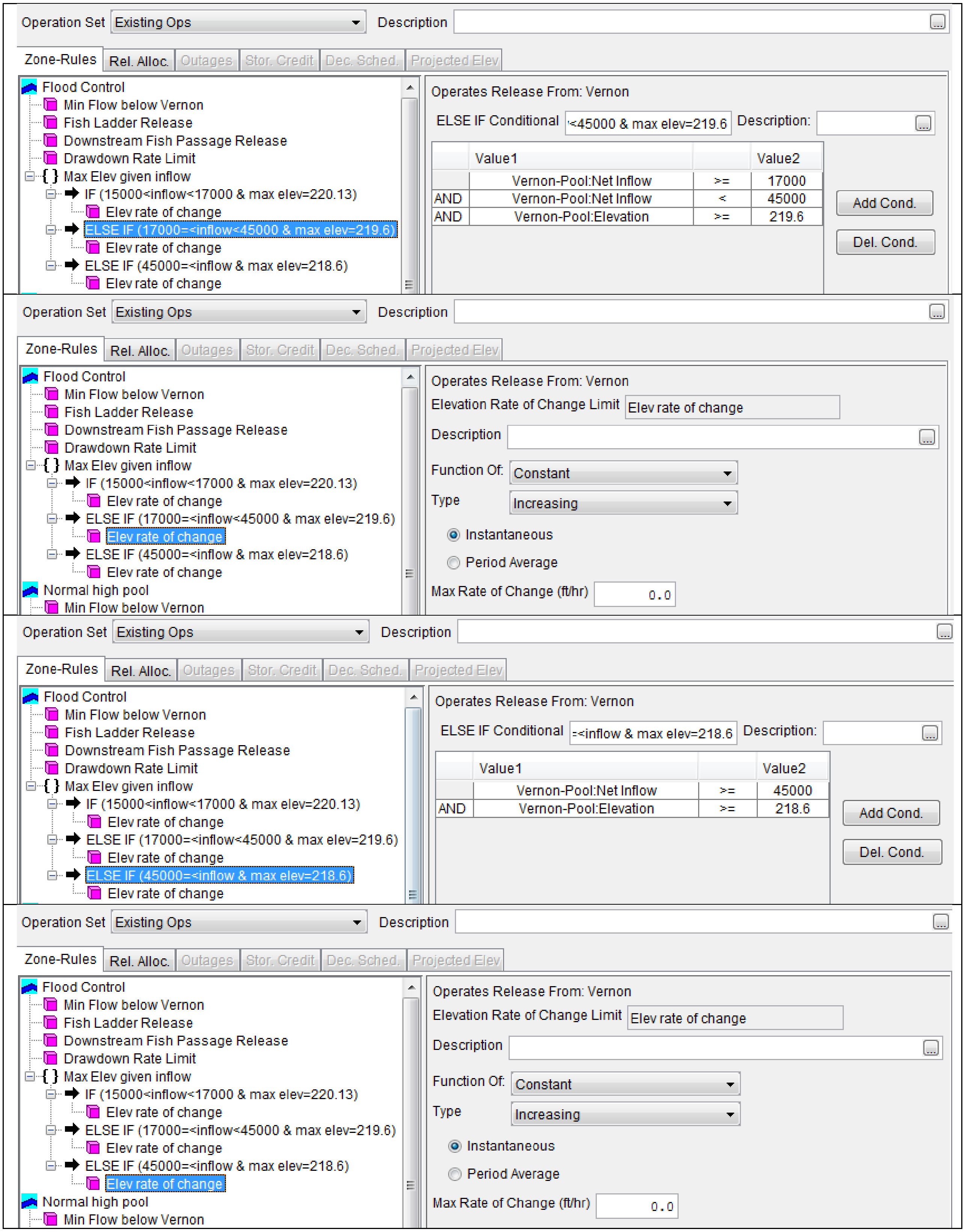


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Elev given inflow

6. Hydropower-Release 95% Inflow

Figure 13 shows the content of “Hydropower-Release 95% Inflow” rule. This rule passes 95% of Inflow through power plant as per the run-of-river modeling strategy.

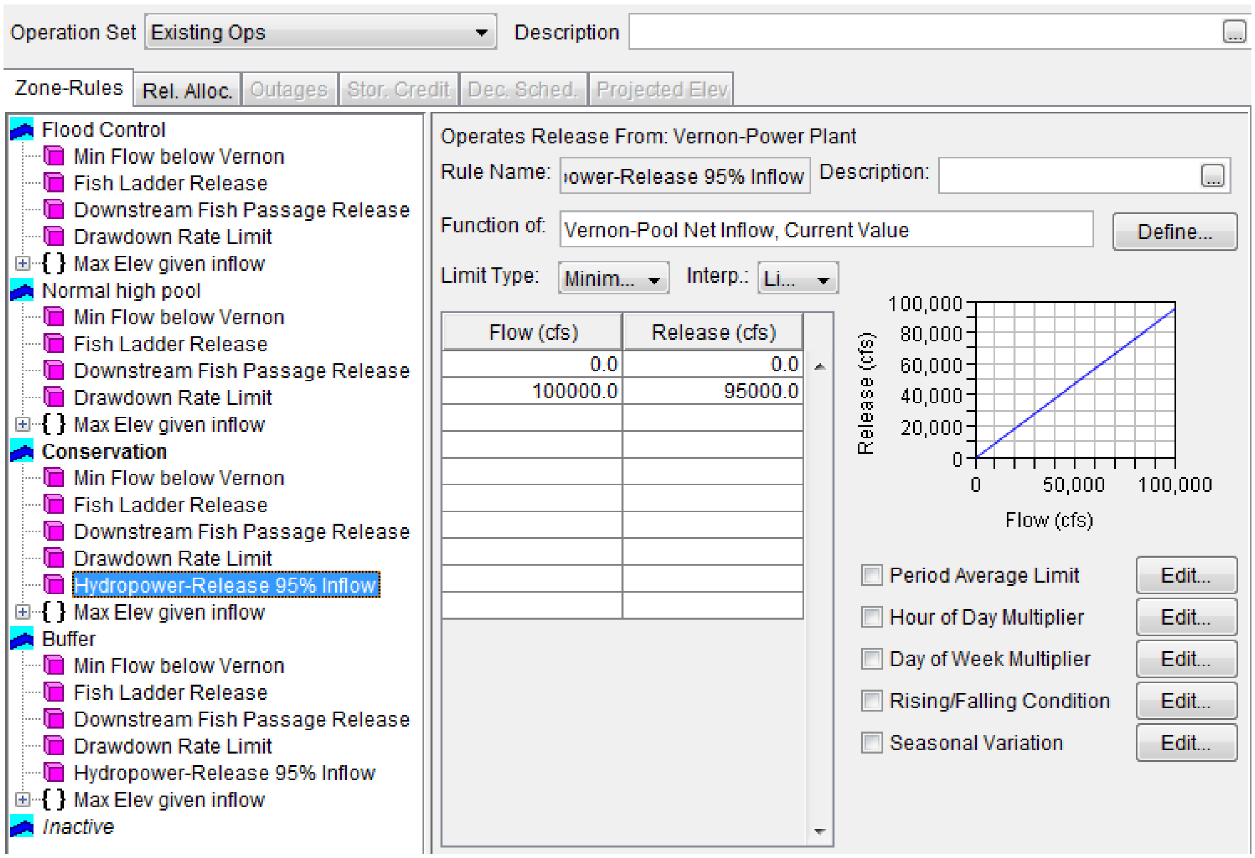


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Hydropower-Release 95% Inflow

Ware Upper and Lower

I. Overview

Ware Upper and Lower are two dams located in Ware, MA on the Ware River. It is owned and operated by Ware River Hydroelectric Company and is used to generate hydropower.

Figure 1 shows the location of Ware upper and lower dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Ware upper dam.

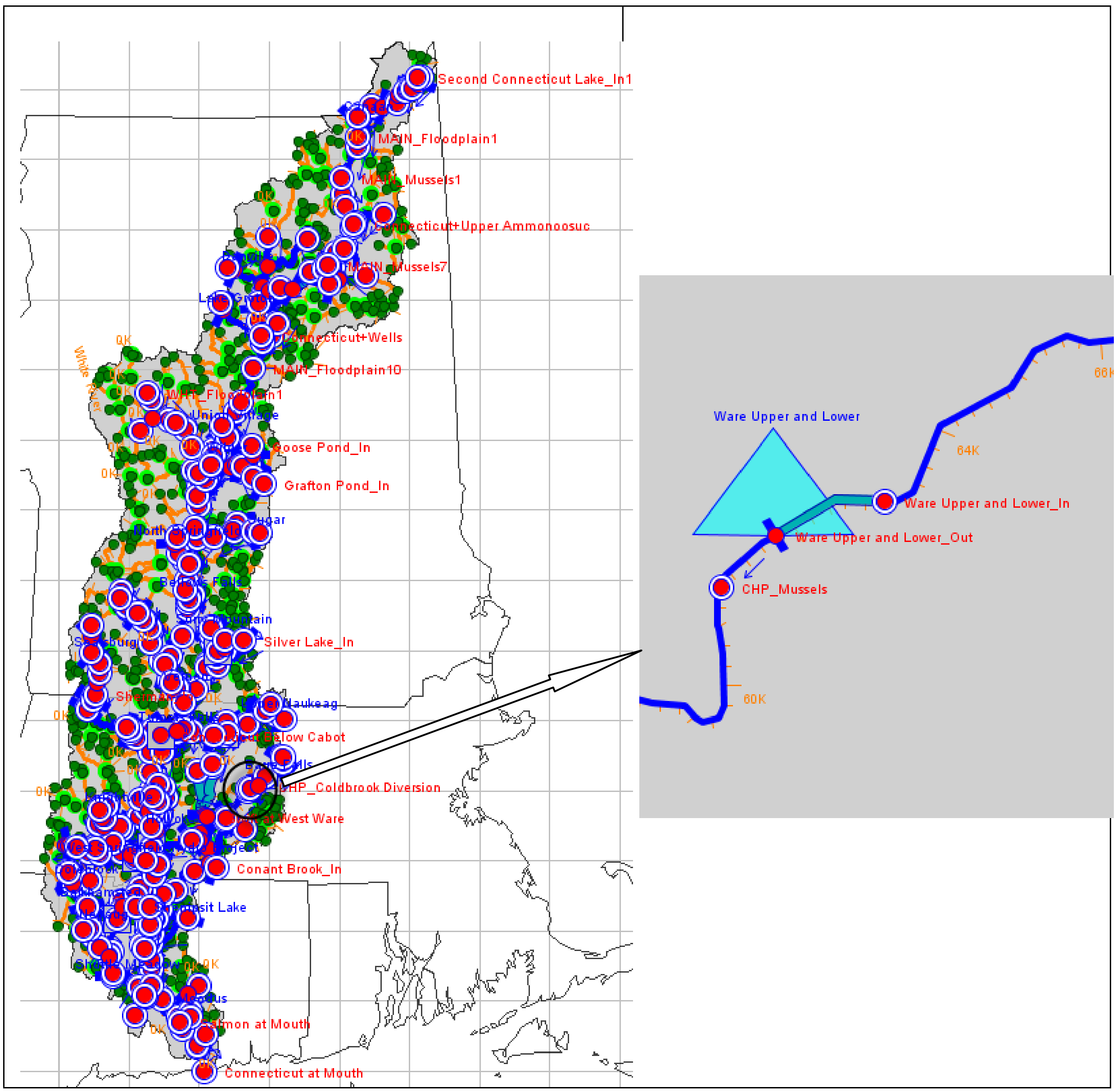


Figure 1: HEC-ResSim Map Display Showing Location of Ware upper and lower Dam

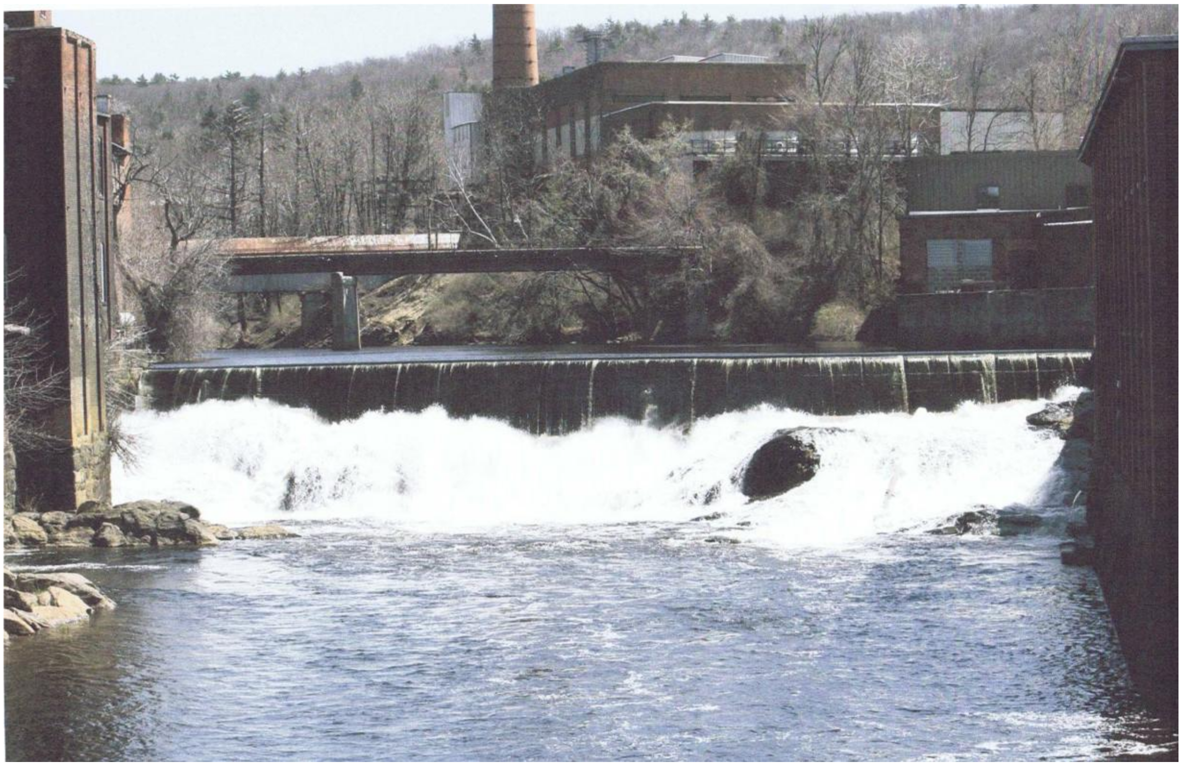


Figure 2: Photo of Ware upper dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[105]. The dam consists of two types of outlets: (1) uncontrolled outlet and (3) power plant as shown in Figure 4 [1,106]. The capacity of the power plant was made to be the maximum release specified in the NID database so that the dam would modeled completely as run-of-river with some actual physical information.

[105] National Inventory of Dams database (NID)

[106] http://www.lowimpacthydro.org.php5-11.dfw1-2.websitetestlink.com/lihi-certificate-47-ware-river-hydroelectric-company-project-ferc-no.-3127-ware-river-massachusetts.html

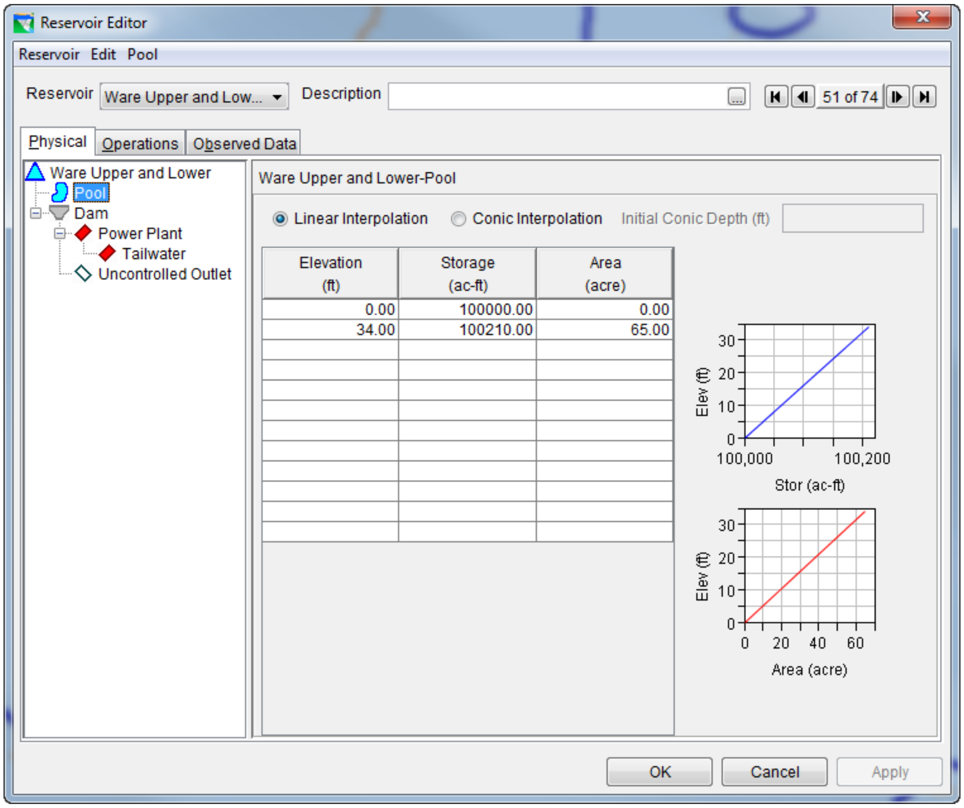


Figure 3: Reservoir Editor: Physical Tab – Pool

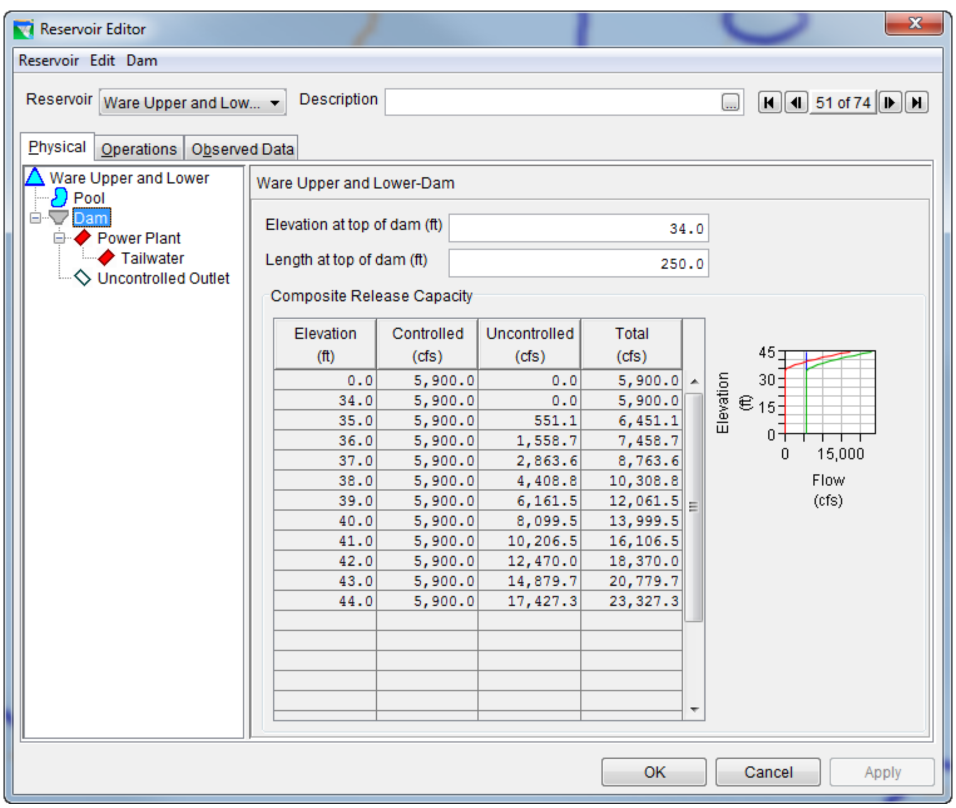


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Ware upper and lower's "Guide Curve" operational zones, which consist of Flood Control (34 ft), Conservation (33.9 ft), and Inactive zone (24 ft)[1]. There was no specified inactive zone so 10 feet below top of dam was arbitrarily chosen.

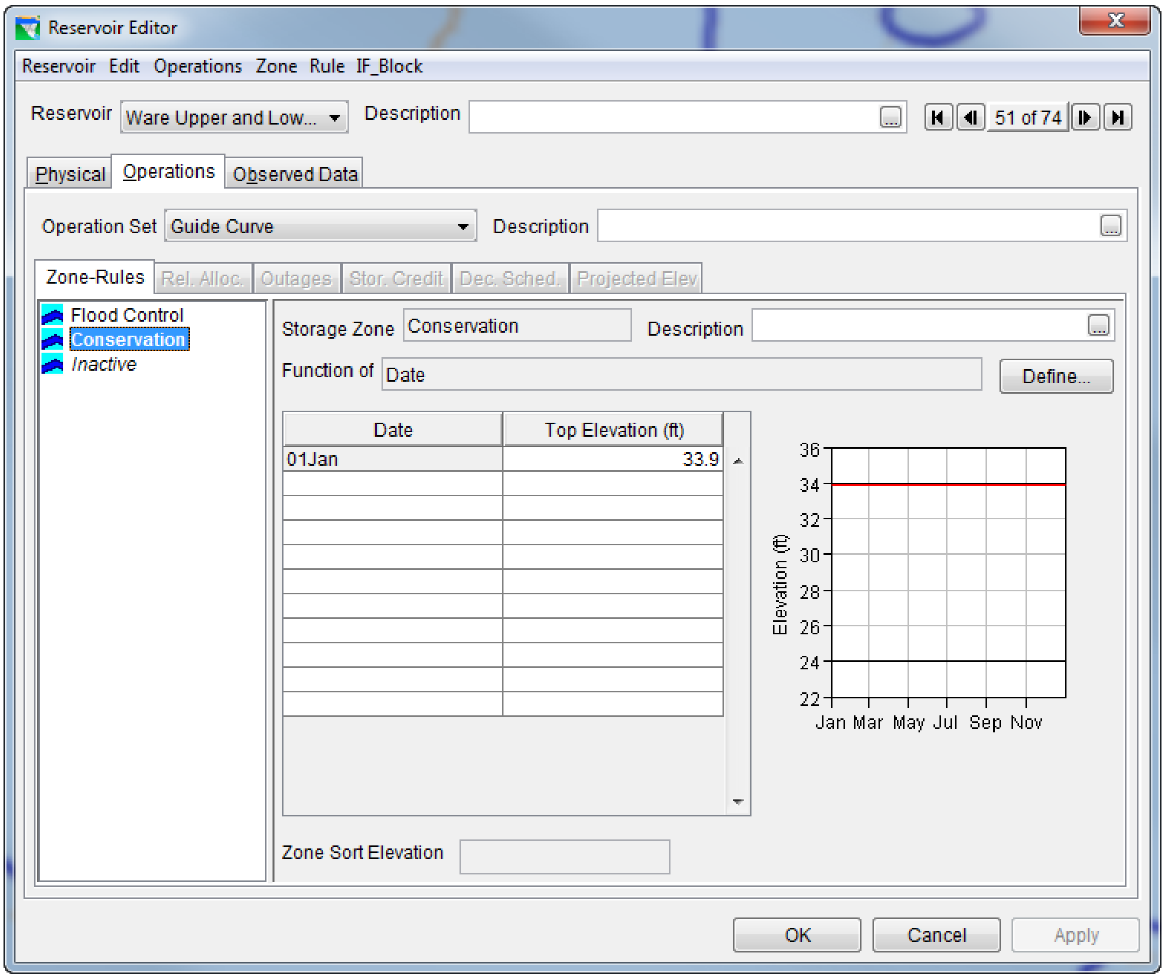


Figure 5: Reservoir Editor: Operations Tab –Guide Curve OpSet – Guide Curve

B. Rule Illustrations

The operation set for Ware upper and lower has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity. This was modeled this way because no real operation information was found.

West Branch

I. Overview

West Branch dam (known as Goodwin Dam) is located directly downstream of Colebrook dam on the Farmington River in Hartland, CT. It is owned and operated by The Metropolitan Water District of Hartford, CT (MDC) and is used for drinking water supply and some recreation.

Figure 1 shows the location of West Branch as it is represented in the HEC-ResSim model, and Figure 2 shows a photo for West Branch.

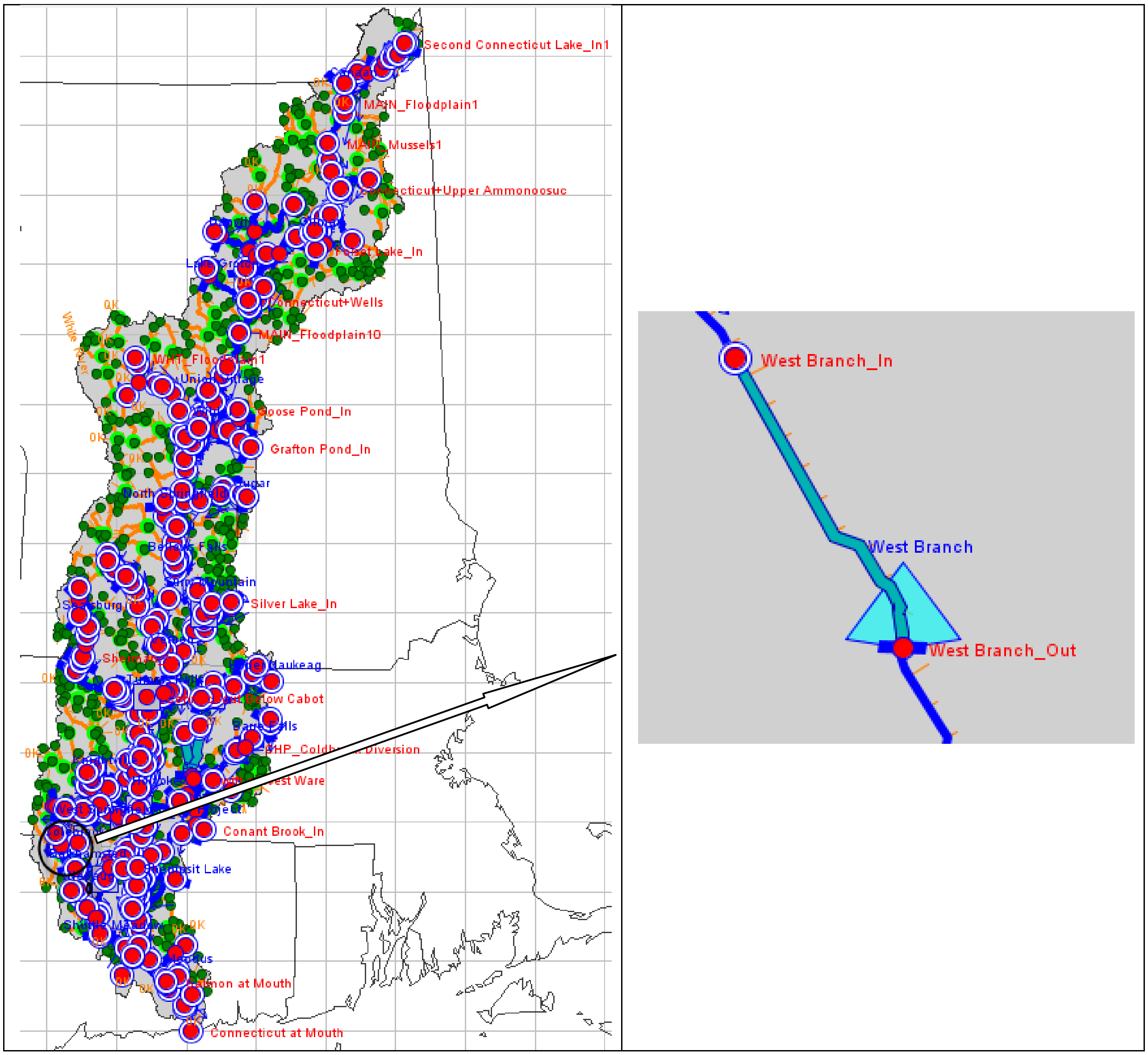


Figure 1: HEC-ResSim Map Display Showing Location of West Branch

Figure 2: Photo of West Branch dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[107]. The dam consists of a controlled outlet as shown in Figure 4[108].

[107] MDC 1999
[108] Data from UMASS

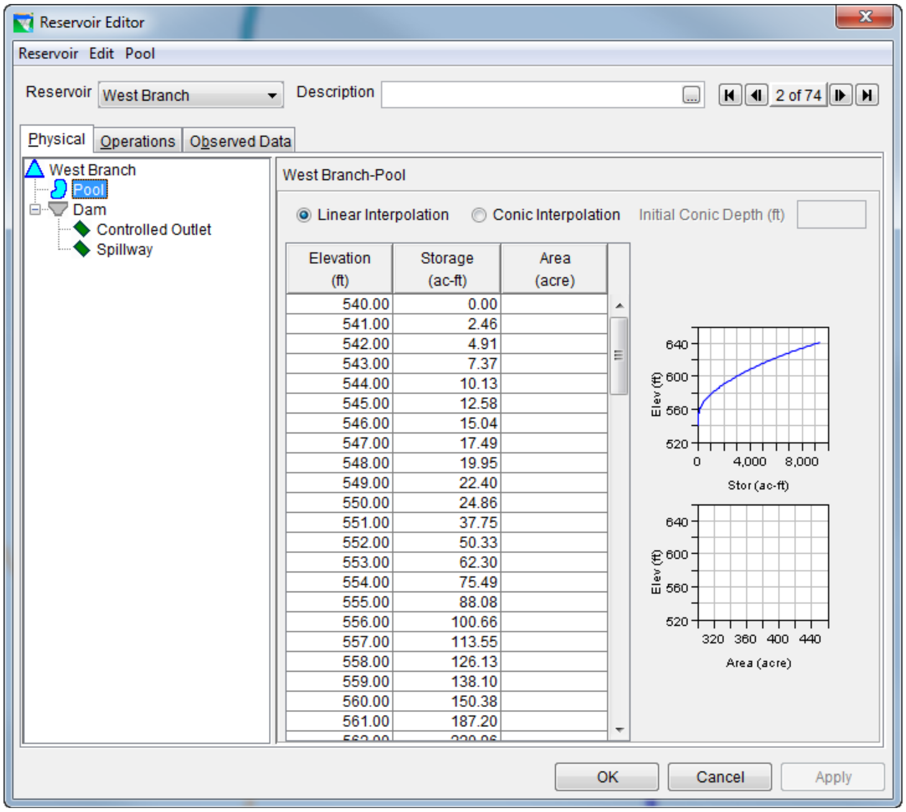


Figure 3: Reservoir Editor: Physical Tab -- Pool

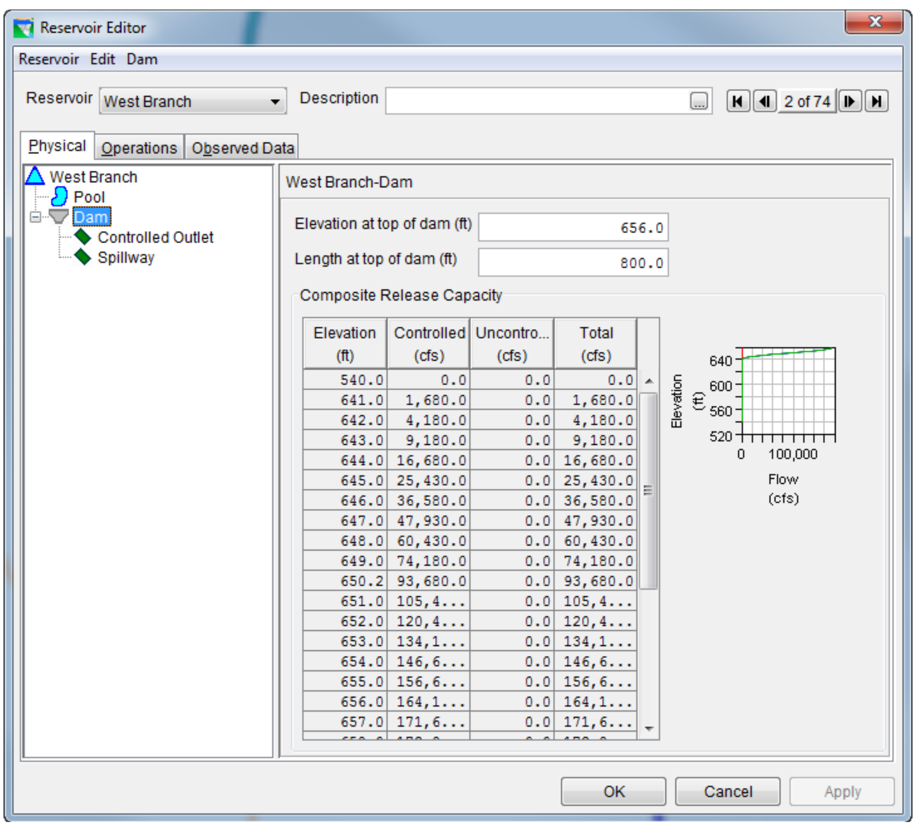


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of West Branch's "Existing Ops" operational zones, which consist of zones of Top of Dam (656 ft), Conservation (641 ft), and Inactive zone (540 ft)[2].

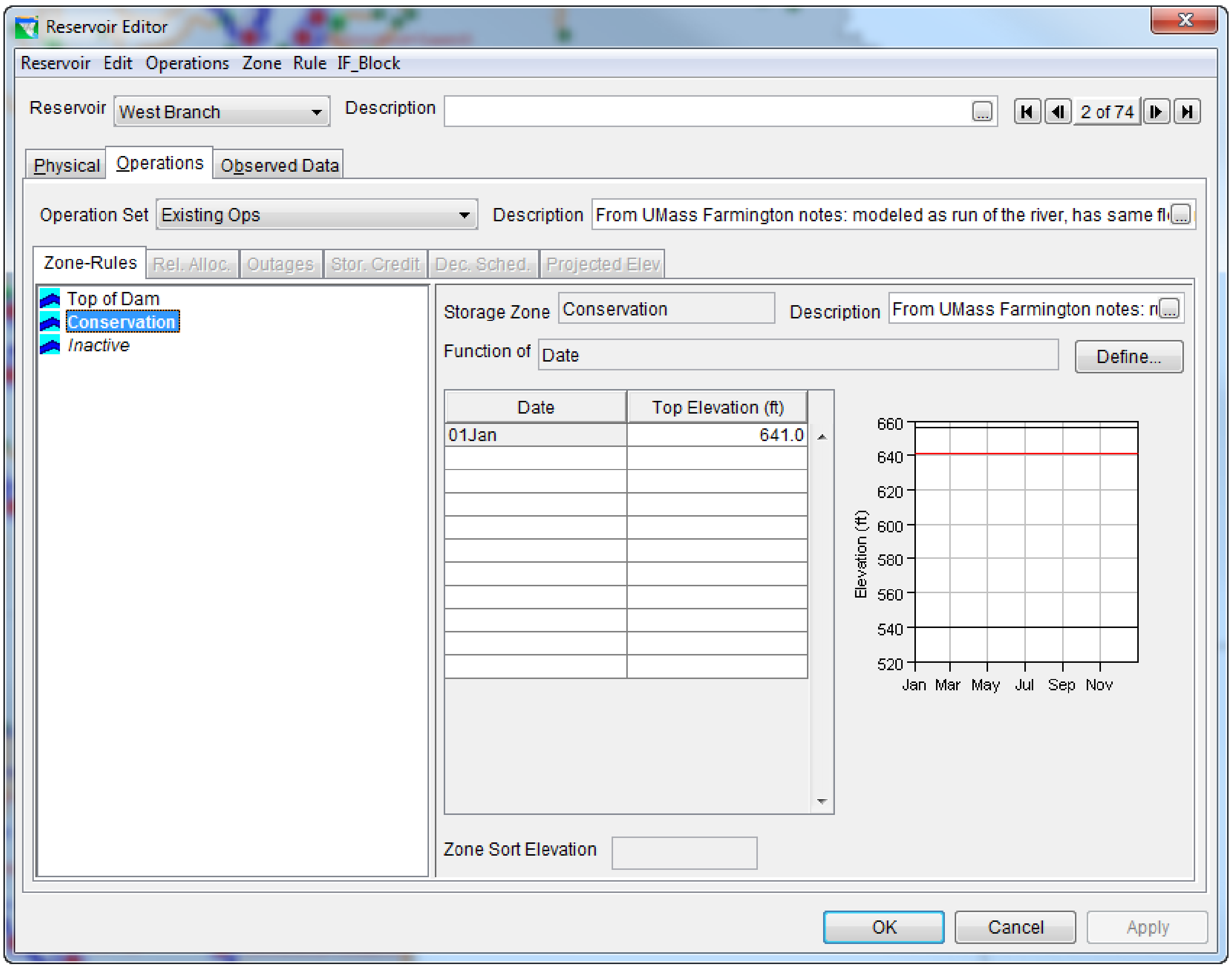


Figure 5: Reservoir Editor: Operations Tab – Existing Ops OpSet

B. Rule Illustrations

The operation set for West Branch has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

West Springfield Hydro Project

I. Overview

West Springfield is dam located in West Springfield, MA on the Westfield River. It is owned and operated by A&D Hydro, Inc and is used for hydropower generation.

Figure 1 shows the location of West Springfield dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of West Springfield dam.

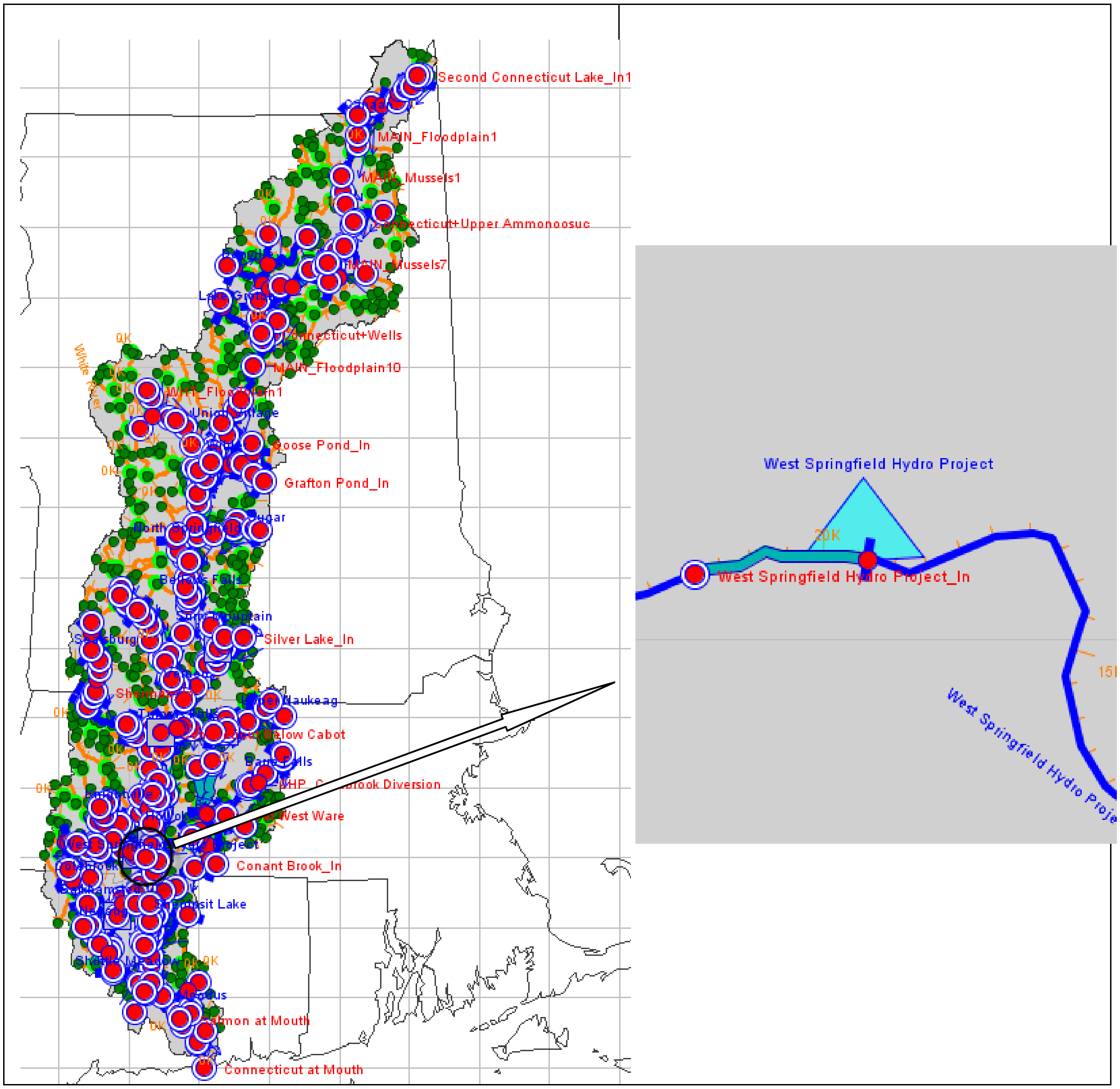


Figure 1: HEC-ResSim Map Display Showing Location of West Springfield Dam

Figure 2: Photo of West Springfield dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[109]. The dam consists of two types of outlets: (1) uncontrolled outlet and (3) power plant as shown in Figure 4[110]. The capacity of the power plant was made to be the maximum release specified in the NID database so that the dam would modeled completely as run-of-river with some actual physical information.

[109] National Inventory of Dams database (NID)

[110] http://www.lowimpacthydro.org/lihi-certificate-19-west-springfield-project-westfield-river-west-springfield-agawam-ma.-ferc-2608.html

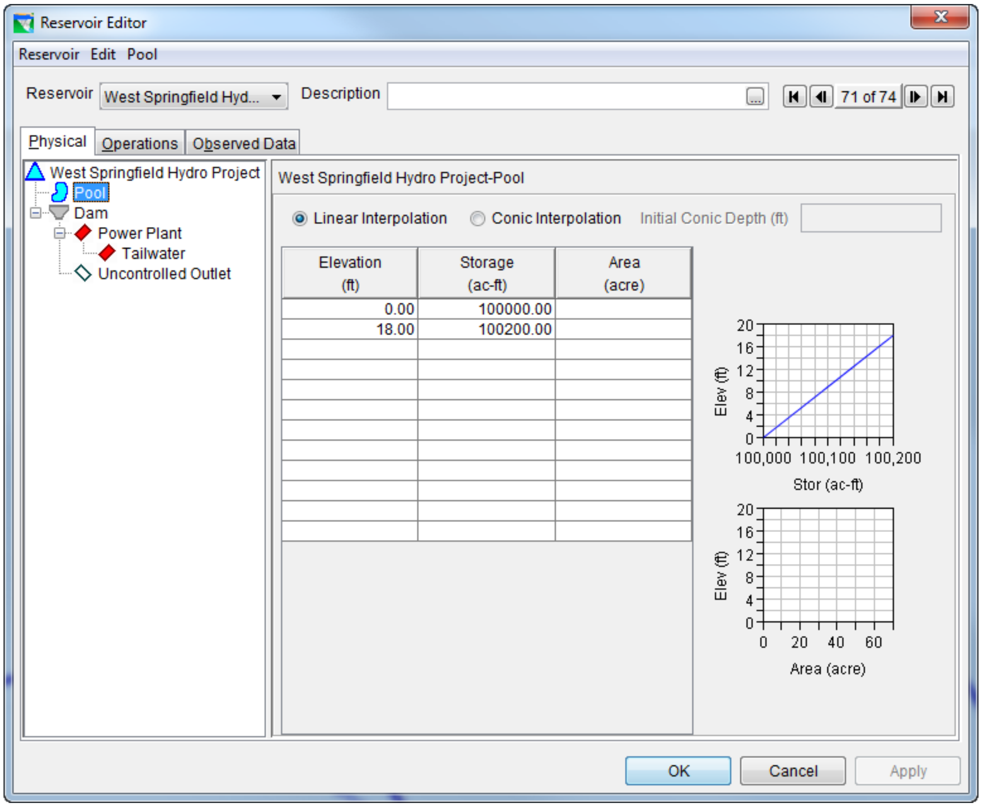


Figure 3: Reservoir Editor: Physical Tab – Pool

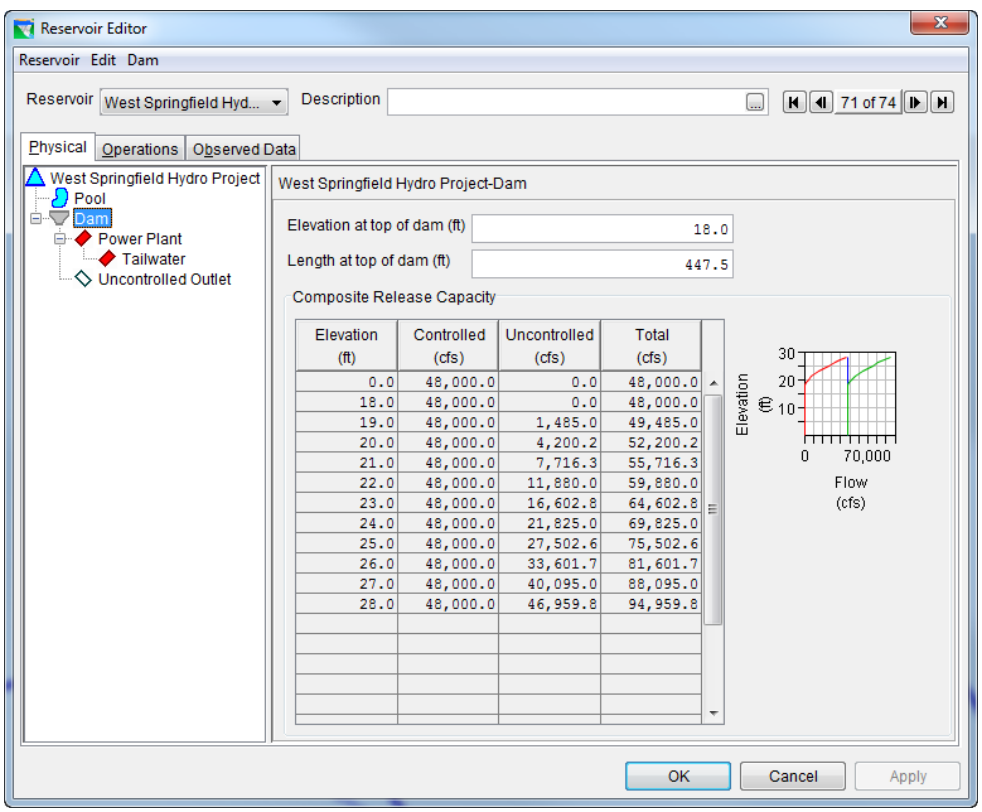


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of West Springfield's "Guide Curve" operational zones, which consist of Flood Control (18 ft), Conservation (17.9 ft), and Inactive zone (8 ft)[1]. There was no specified inactive zone so 10 feet below top of dam was arbitrarily chosen.

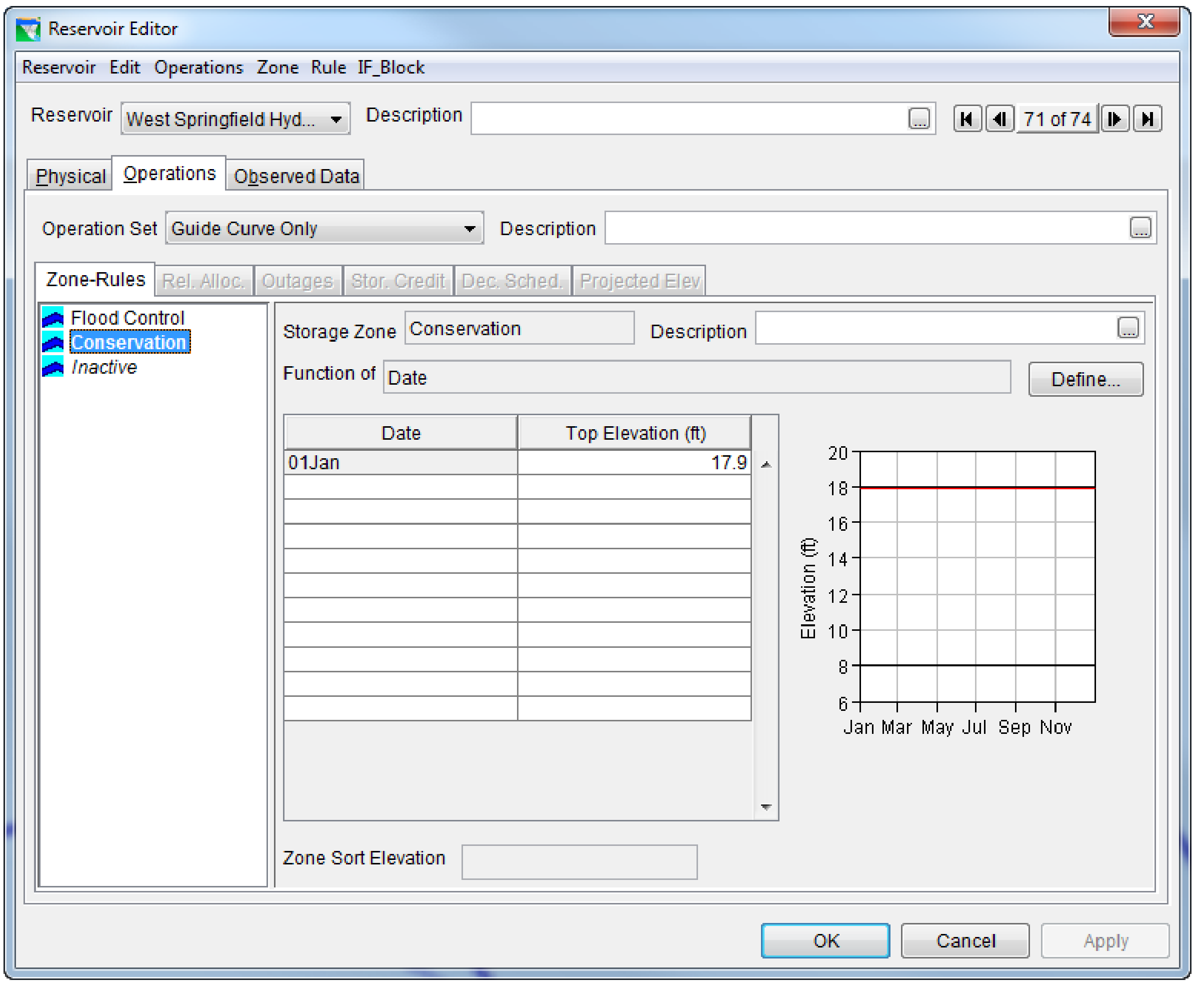


Figure 5: Reservoir Editor: Operations Tab –Guide Curve OpSet – Guide Curve

B. Rule Illustrations

The operation set for West Springfield has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity. This was modeled this way because no real operation information was found.

Whitney Pond

I. Overview

Whitney Pond dam is located in the Town of Winchendon, MA at the confluence of the North Branch and Millers River. It is owned and operated by the Town of Winchendon and is used for water supply for the town.

Figure 1 shows the location of Whitney Pond dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Whitney Pond.

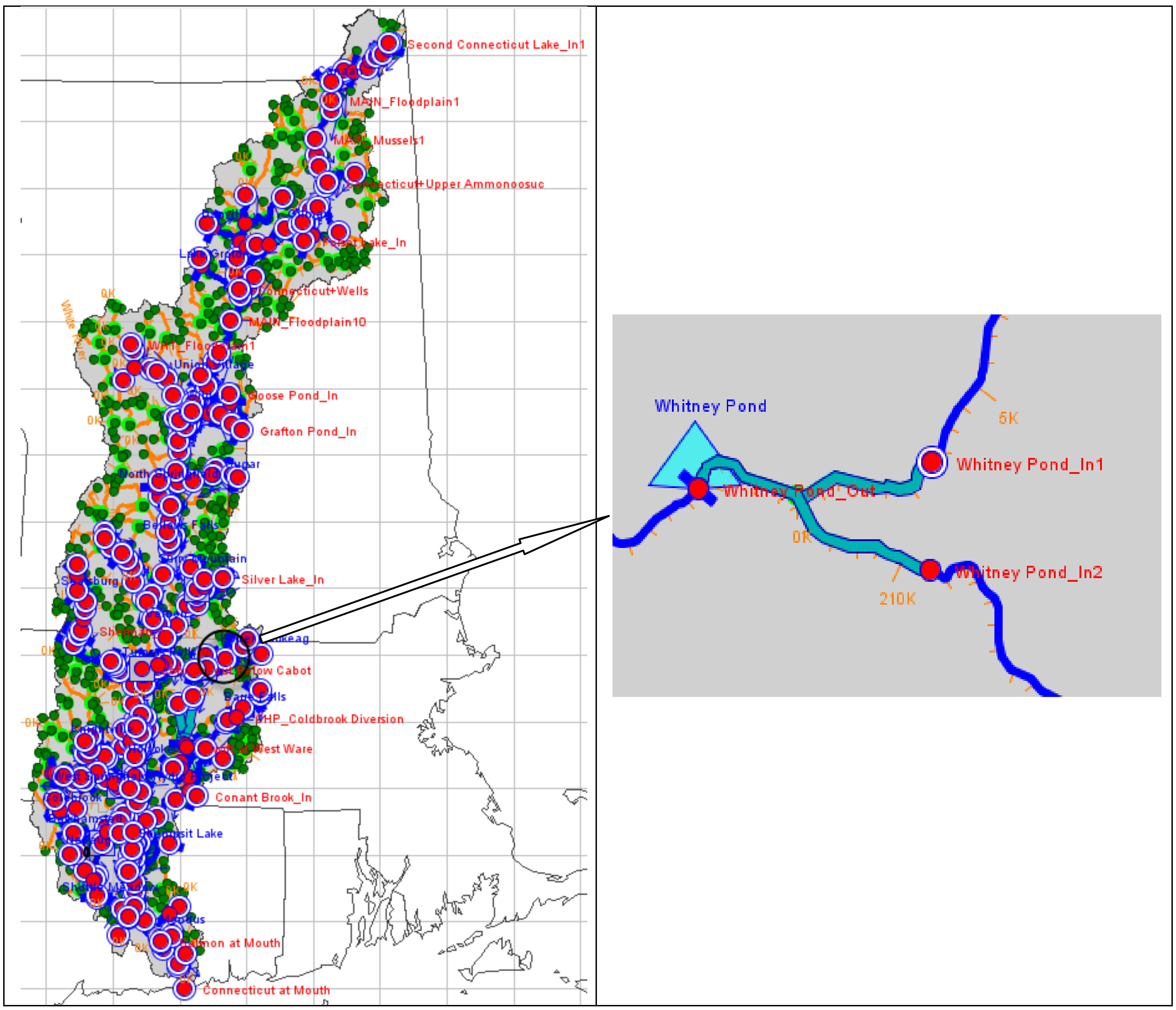


Figure 1: HEC-ResSim Map Display Showing Location of Whitney Pond Dam

Figure 2: Photo of Whitney Pond

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[111]. The dam consists of two types of outlets: (1) an uncontrolled Outlet and an uncontrolled flow over embankment as shown in Figure 4.

[111] Phase I National Dam Inspection Program. 1979.

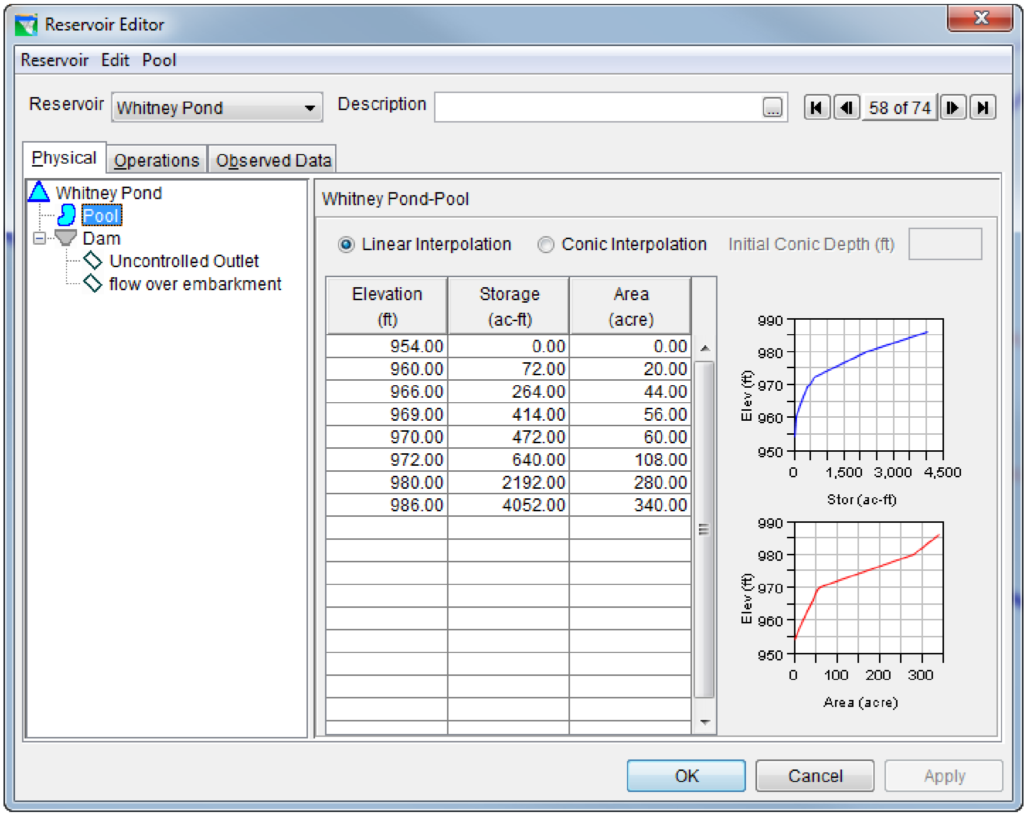


Figure 3: Reservoir Editor: Physical Tab -- Pool

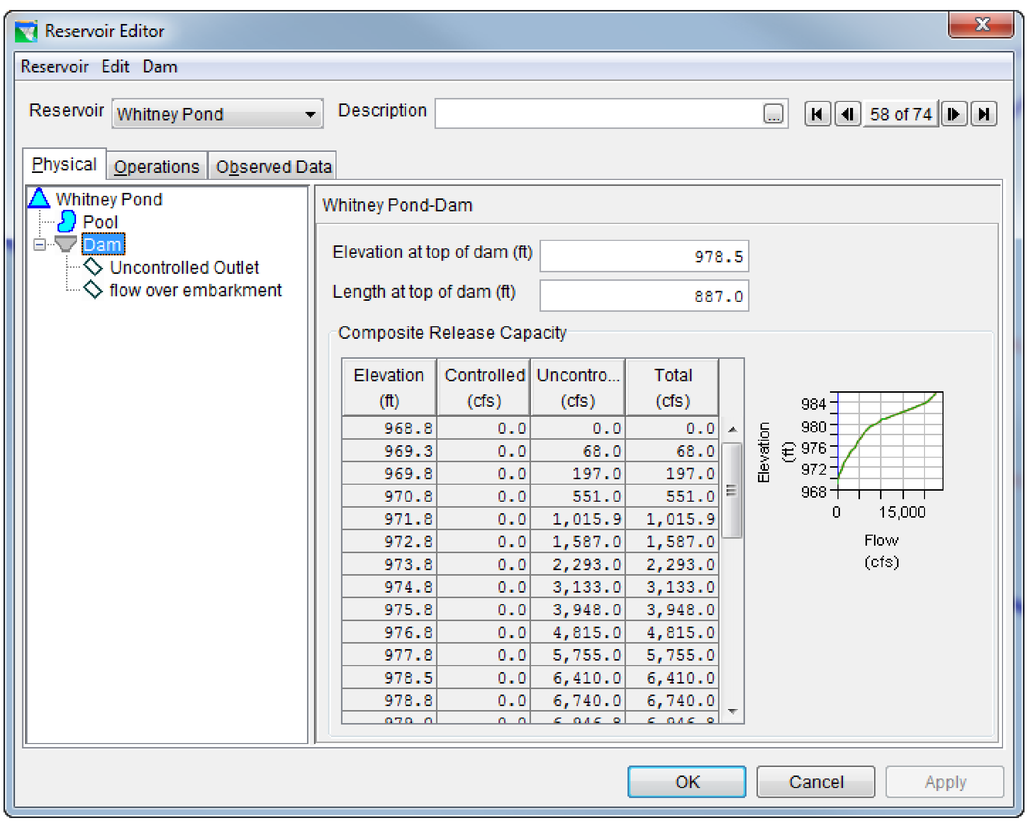


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Whitney Pond Dam's "Guide Curve" operational zones, which consist of zones of Top of Dam (978.5 ft), Flood Control (970 ft), Conservation (968.8 ft), and Inactive zone (955 ft)[1].

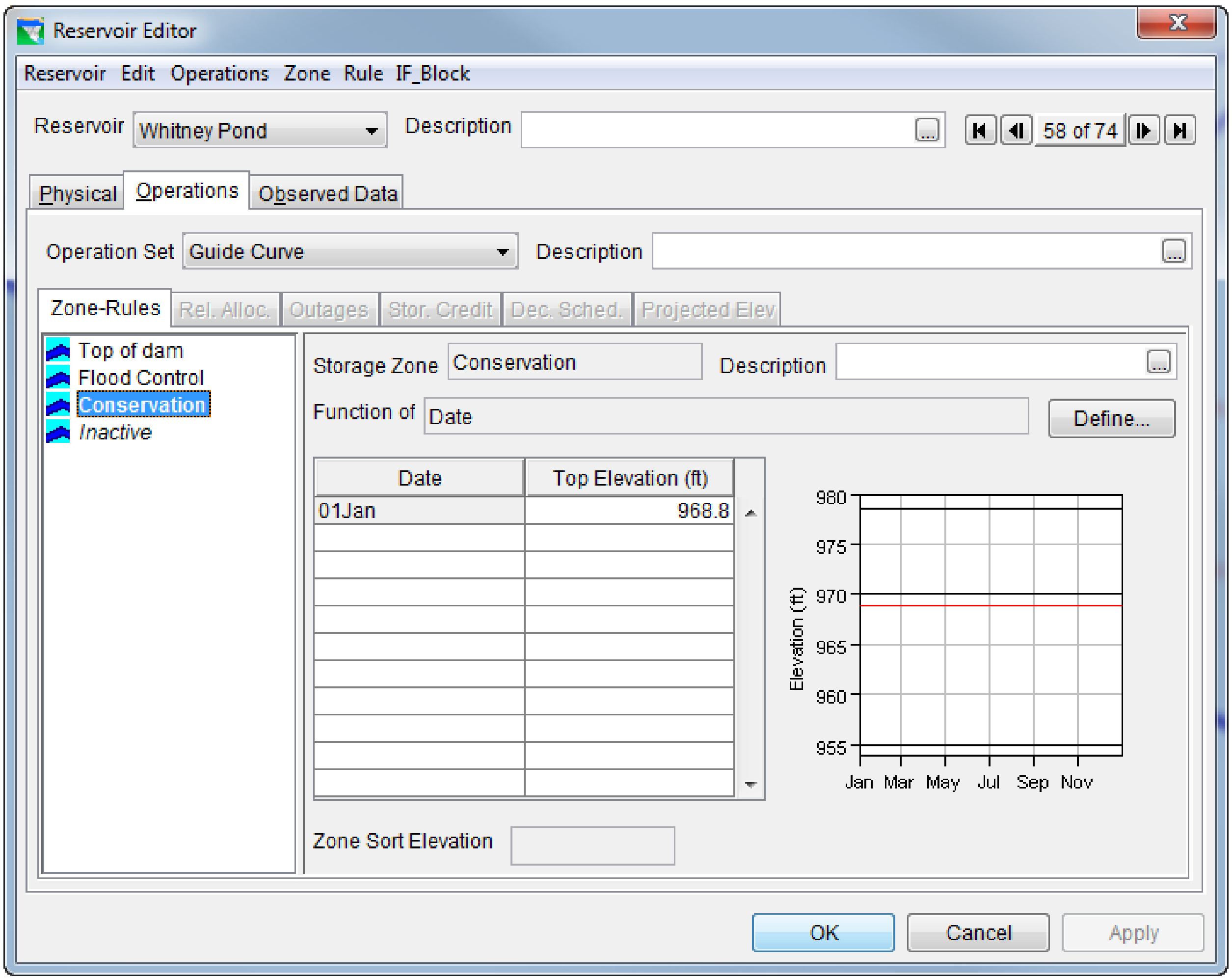


Figure 5: Reservoir Editor: Operations Tab – Guide Curve OpSet

B. Rule Illustrations

The operation set for Whitney Pond Dam has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity.

Wilder

I. Overview

Wilder dam is located in the town of Wilder, VT on the mainstem Connecticut River. It is owned and operated by TransCanada Hydro Northeast Inc. for hydropower generation.

Figure 1 shows the location of Wilder Dam as it is represented in the HEC-ResSim model, and Figure 2 shows a photo from Wilder dam.

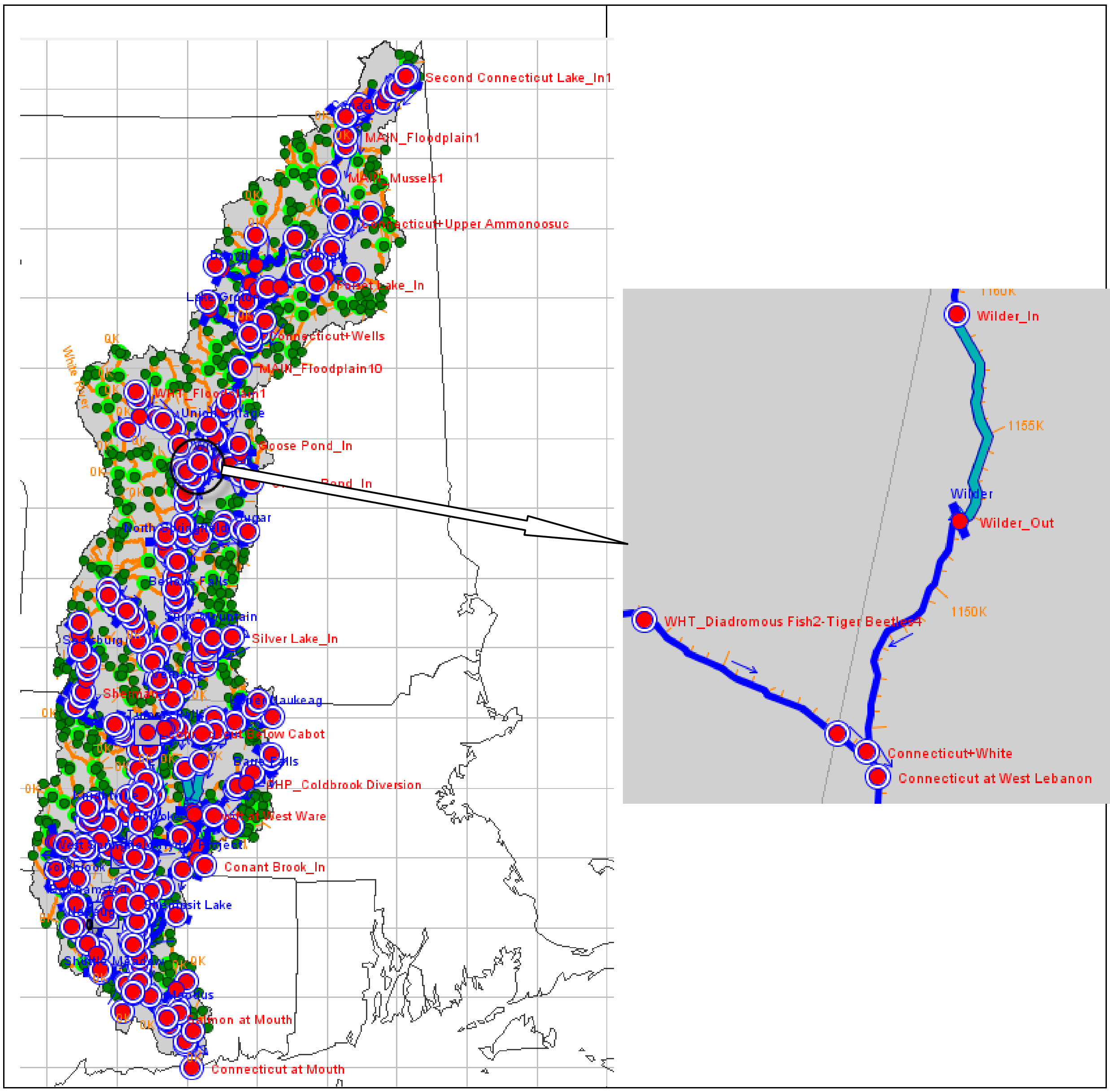


Figure 1: HEC-ResSim Map Display Showing Location of Wilder dam

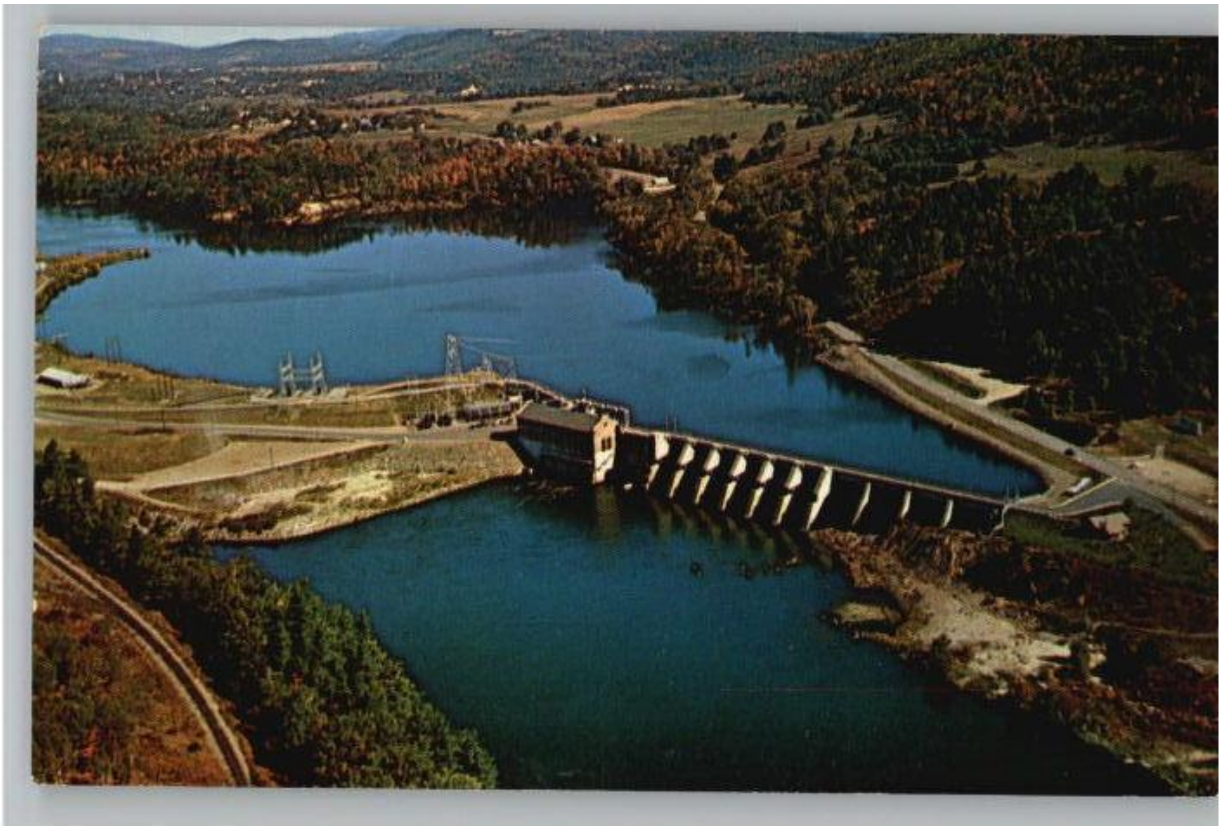


Figure 2: Photo of Wilder dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[112]. The dam consists of six types of outlets: (1) controlled Tainter gates, (2) controlled skimmer gate 10*10 ft, (3) controlled skimmer gate 15*20 ft, (4) controlled Fish Ladder, (5) uncontrolled stanchion-stoplogs in, and (6) power plant as shown in Figure 4.

[112] Data provided by TransCanada

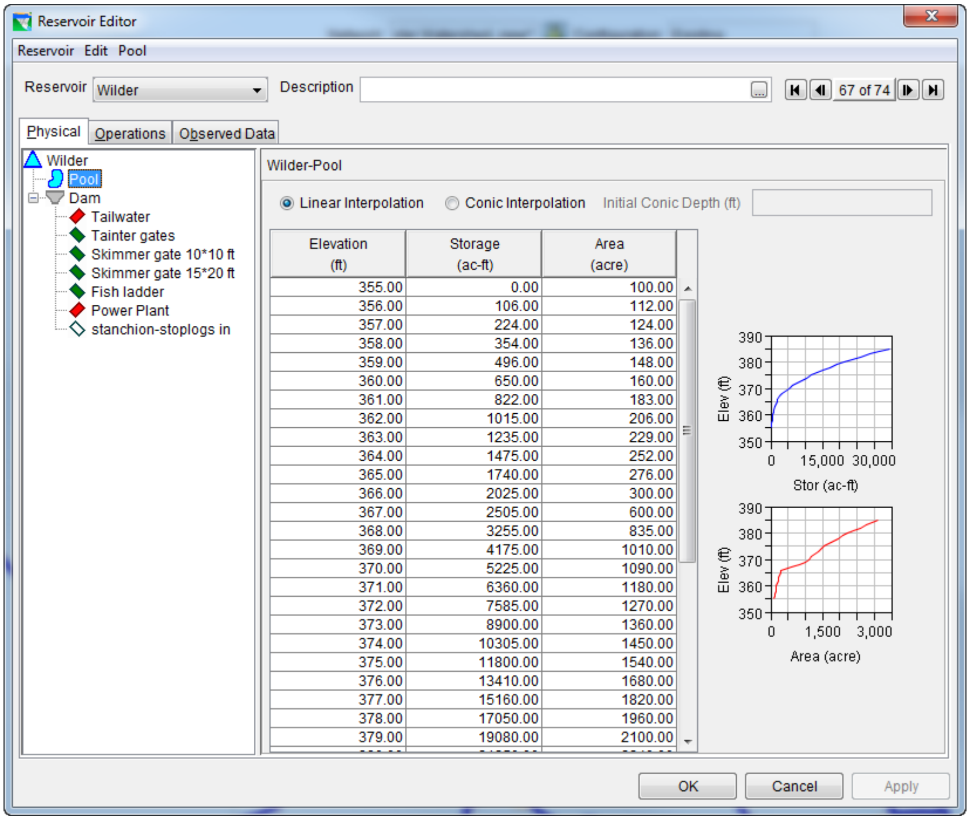


Figure 3: Reservoir Editor: Physical Tab -- Pool

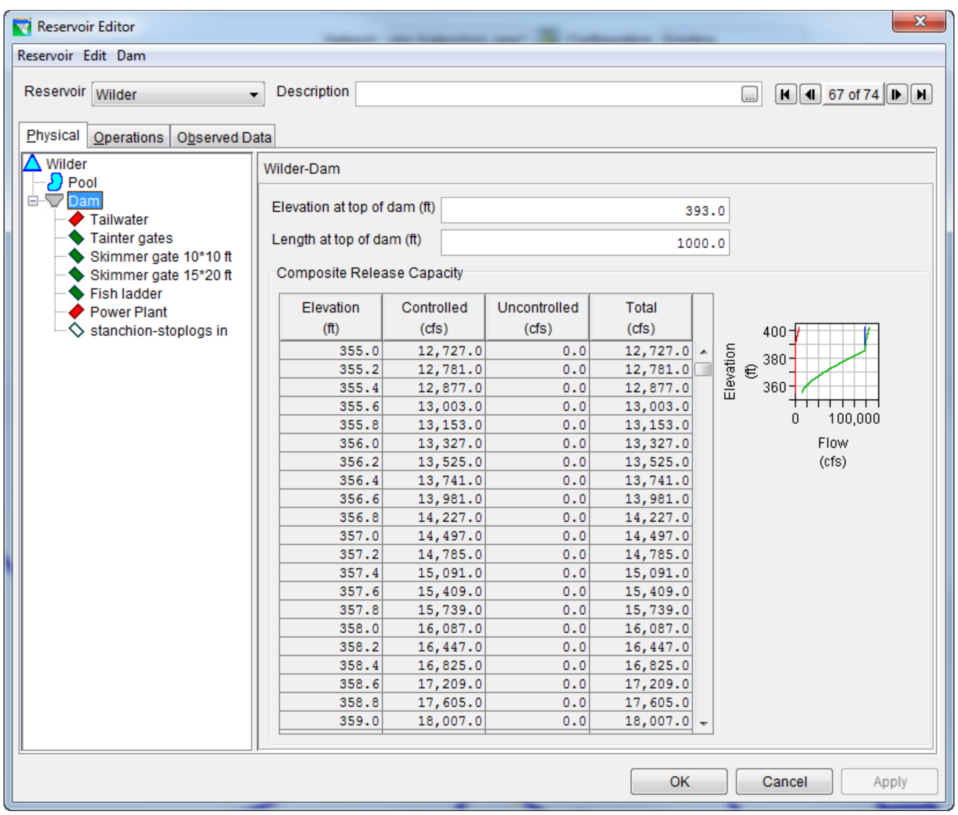


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Wilder's "ExistingOps" operational zones, which consist of zones of Flood Control (393 ft), FERC Max Pool (385 ft), Conservation (384.5 ft), Buffer (382 ft), and Inactive zone (380 ft)[1].

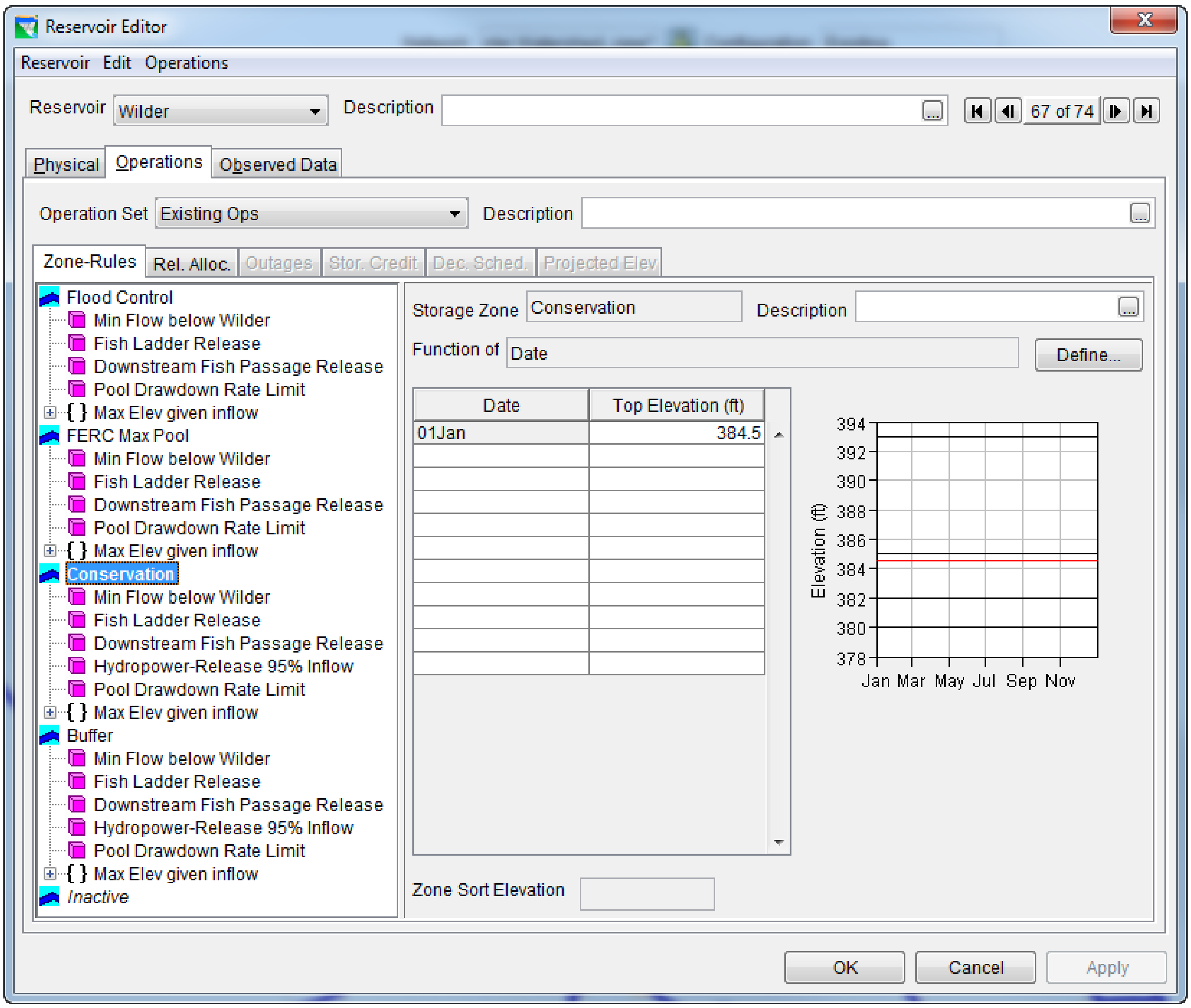


Figure 5: Reservoir Editor: Operations Tab –Existing Ops OpSet – Guide Curve

B. Rule Illustrations

Figure 6 shows a set of operational rules specified for each zone that reflects the operation set named Existing Ops[113].

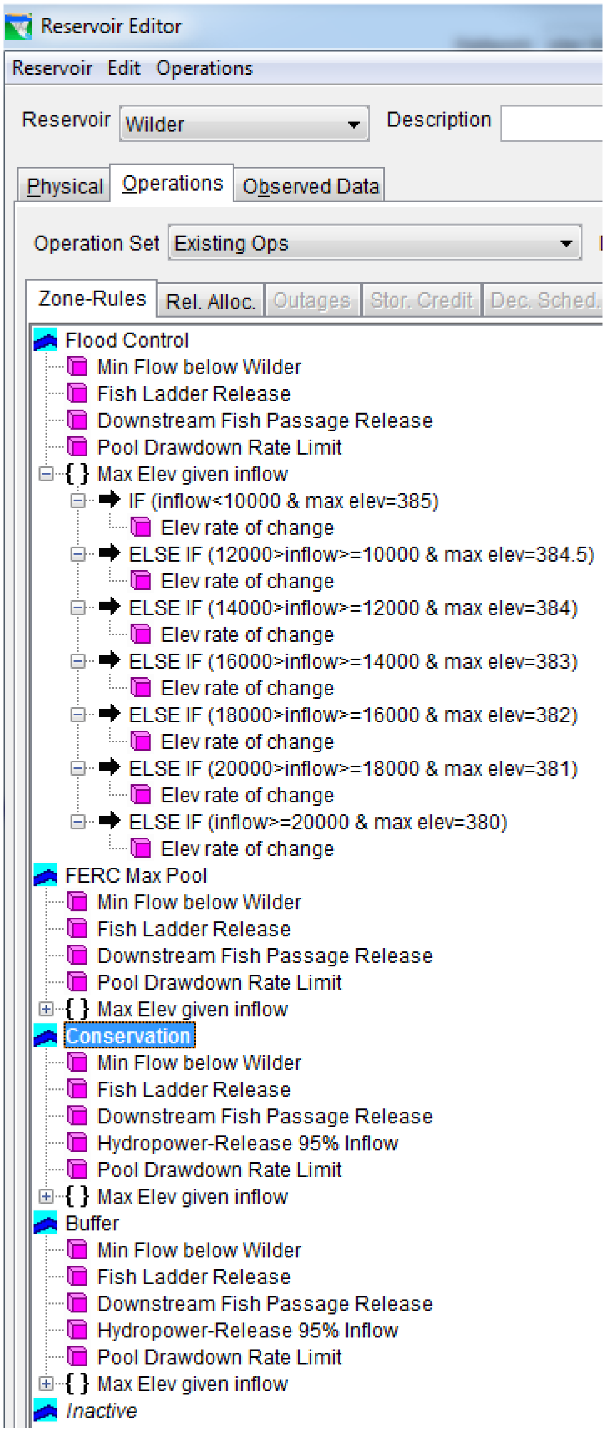


Figure 6: Reservoir Editor: Operations Tab – Existing Ops OpSet – Zones and Rules

[113] TransCanada. Connecticut River Operational Constraints. 2012.

Figure 7 shows a sequential release allocation approach specified for available outlets along Bellows Falls Dam. The available outlets are given an order of priority for release. The power plant gets the release first until it reaches release capacity. The Tainter gates get the remainder of the release until they reache capacity. Then the flow passes through skimmer gate 15*20 and 10*10. After the capacity through the skimmer gates is reached, the remainder of the release goes through the Fish ladder gate.

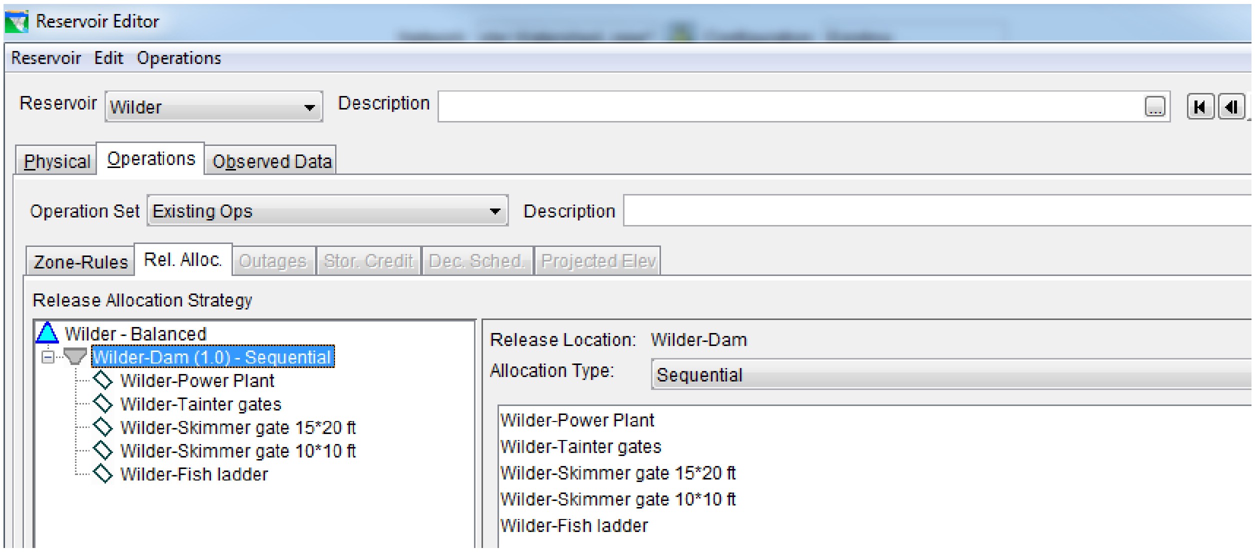


Figure 7: Reservoir Editor: Operations Tab – Existing Ops OpSet – Release Allocation

C. Rule Descriptions

1. Min Flow below Wilder

Figure 8 shows the content of “Min Flow below Wilder” rule. This rule shows a minimum release from dam as a function of Inflow.

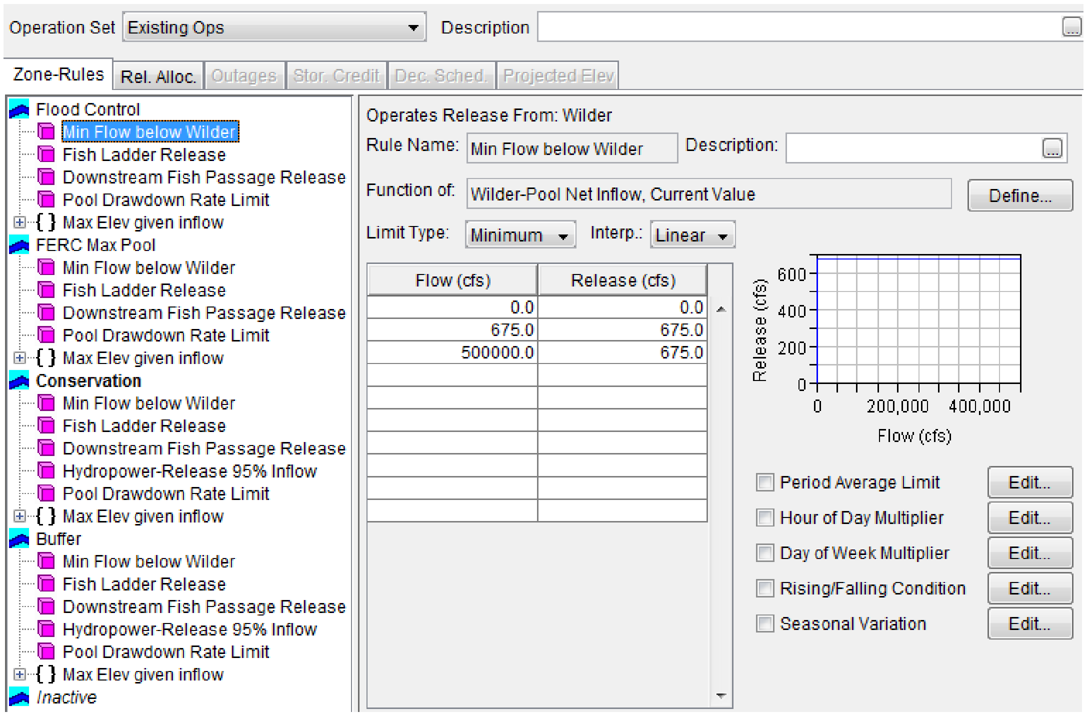


Figure 8: Reservoir Editor: Operations Tab – Existing Ops OpSet – Min Flow below Wilder

2. *Fish Ladder Release*

Figure 9 shows the content of “Fish Ladder Release” rule. This rule shows the specified release from Fish Ladder gate.

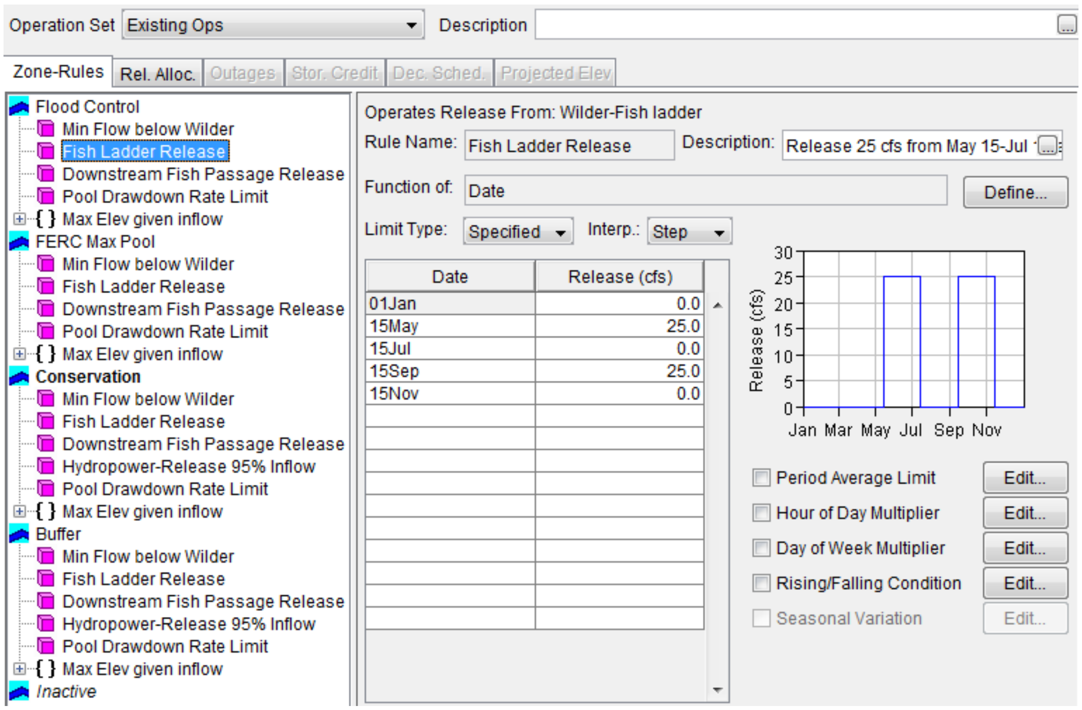


Figure 9: Reservoir Editor: Operations Tab – Existing Ops OpSet – Fish Ladder Release

3. Downstream Fish Passage Release

Figure 10 shows the content of “Downstream Fish Passage Release” rule. This rule shows the specified release from skimmer gate 15*20 ft.

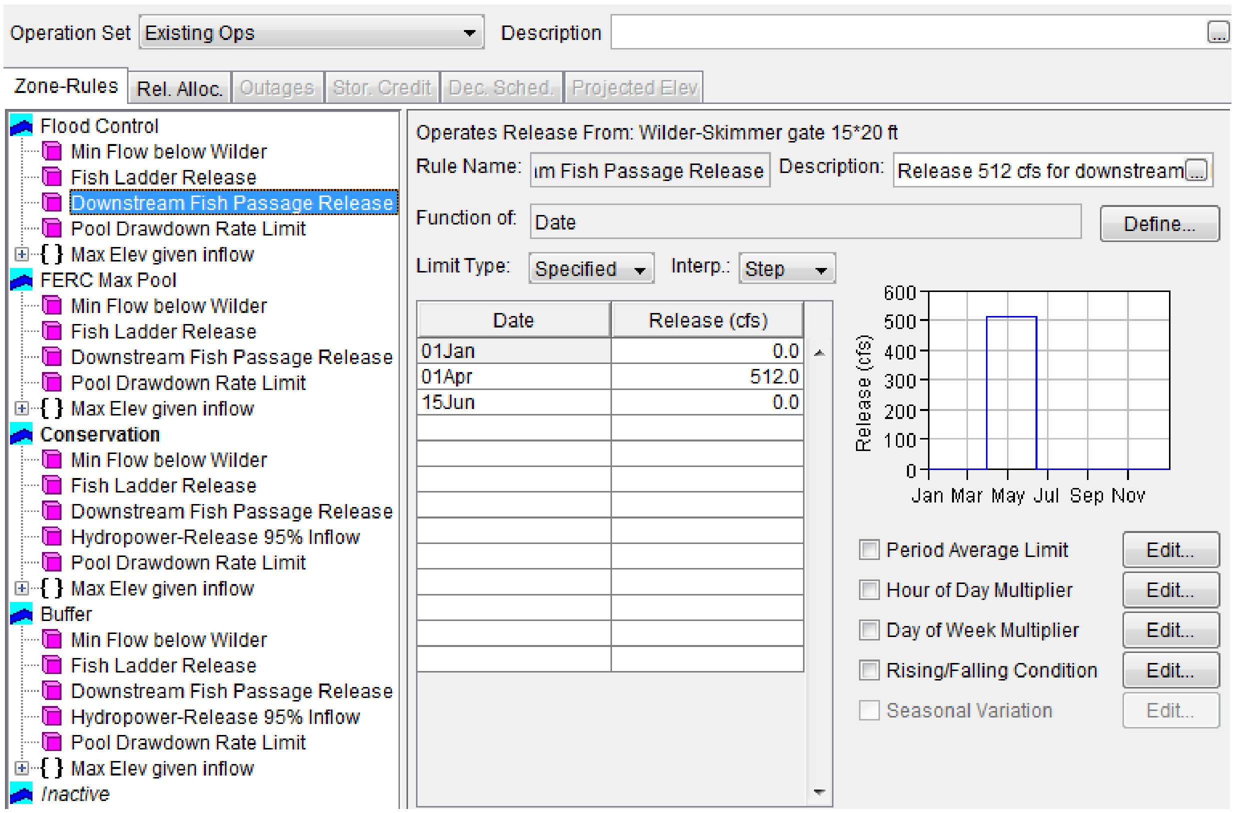


Figure 10: Reservoir Editor: Operations Tab – Existing Ops OpSet – Downstream Fish Passage Release

4. *Pool Drawdown Rate Limit*

Figure 11 shows the content of "Pool Drawdown Rate Limit" rule. This rule shows the decreasing elevation rate of change rule.

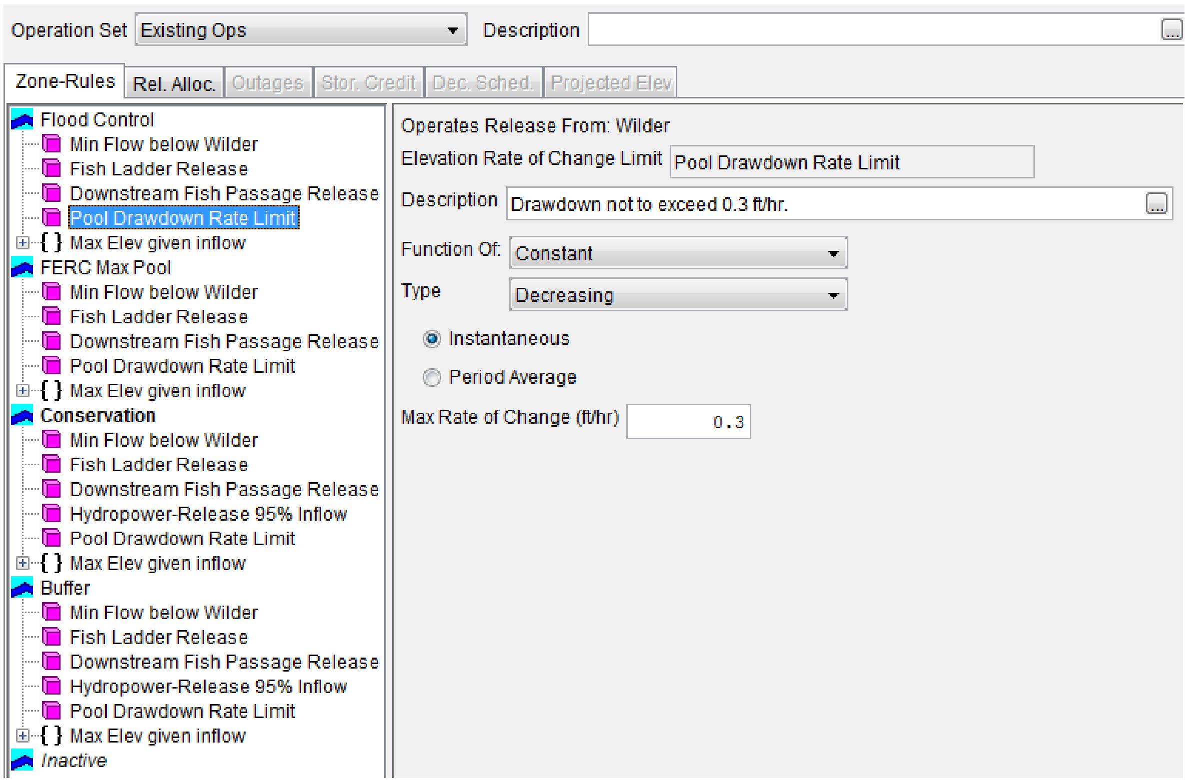


Figure 11: Reservoir Editor: Operations Tab – Existing Ops OpSet – Pool Drawdown Rate Limit

5. *Hydropower-Release 95% Inflow*

Figure 12 shows the content of "Hydropower-Release 95% Inflow" rule. This rule passes 95% of Inflow through power plant. Wilder was modeled as run-of-river even though it has daily peaking operations because the model is a daily time step model.

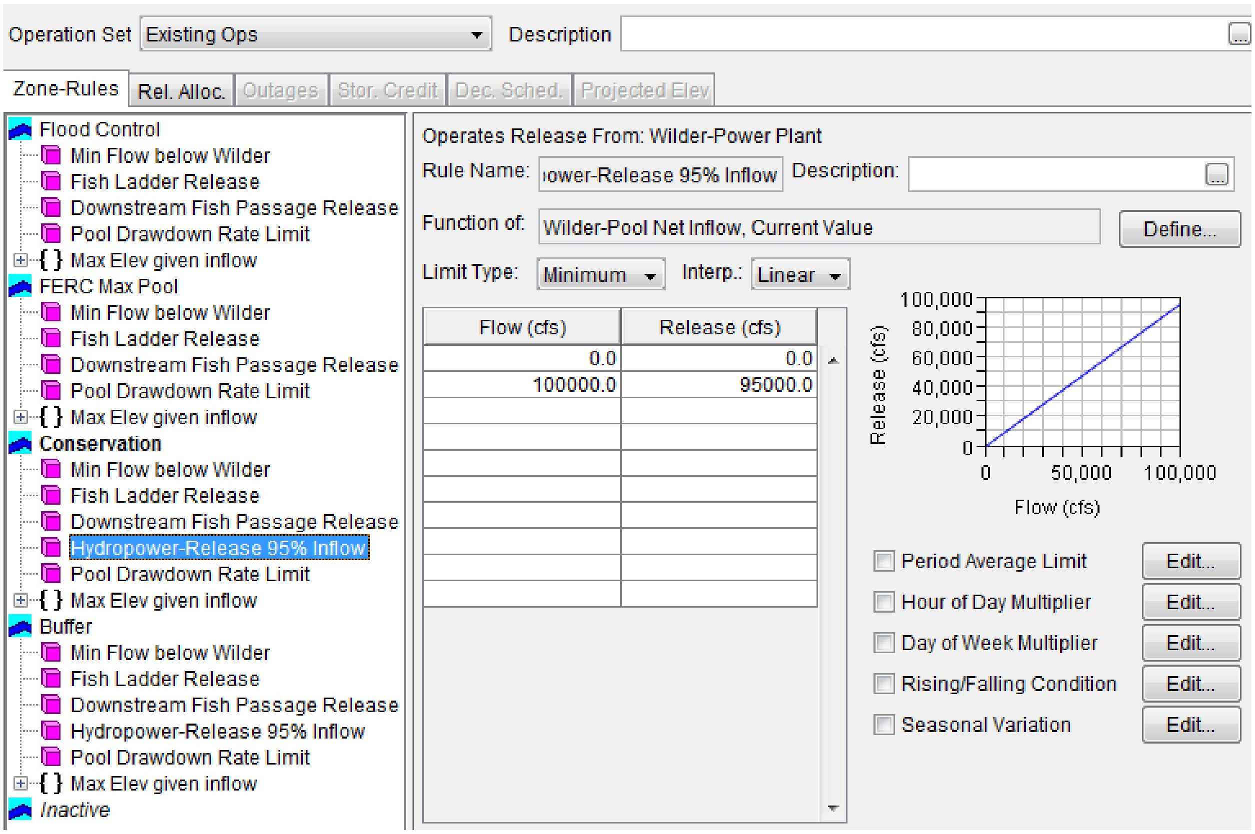


Figure 12: Reservoir Editor: Operations Tab – Existing Ops OpSet – Hydropower-Release 95% Inflow

6. *Max Elev given Inflow*

Figure 13 shows the content of “Max Elev given Inflow” rule. For each combination of Inflow and maximum pool elevation shown in the below picture the maximum elevation rate of change equals zero.

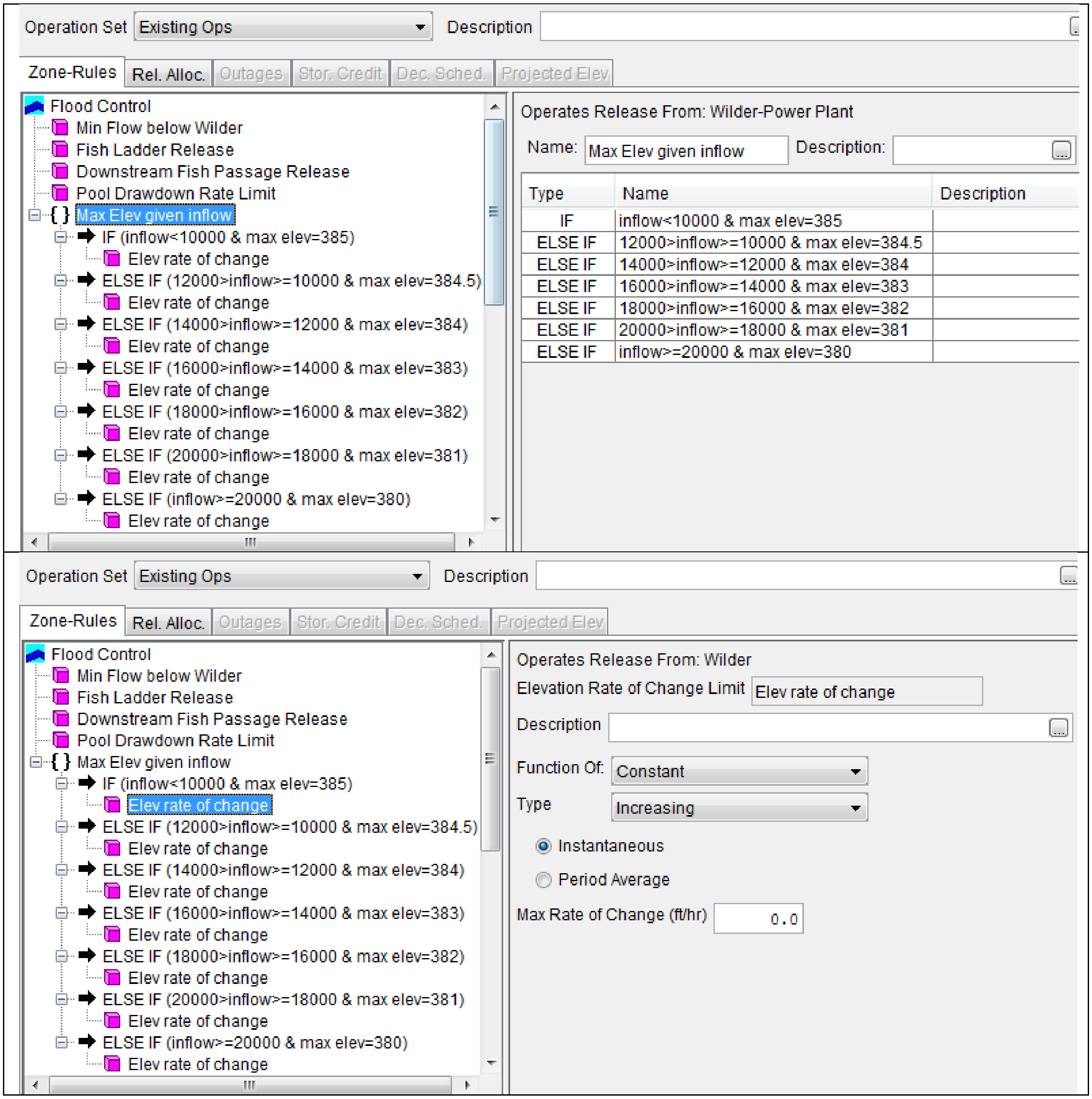


Figure 13: Reservoir Editor: Operations Tab – Existing Ops OpSet – Max Elev given Inflow

Woronoco

I. Overview

Woronoco dam is located two miles below Russell, MA on the Westfield River. It is owned and operated by Swift River Hydro Operations Company and is used for hydropower generation.

Figure 1 shows the location of Woronoco Dam as it is represented in the HEC-ResSim model. Figure 2 shows a photo of Woronoco Dam.

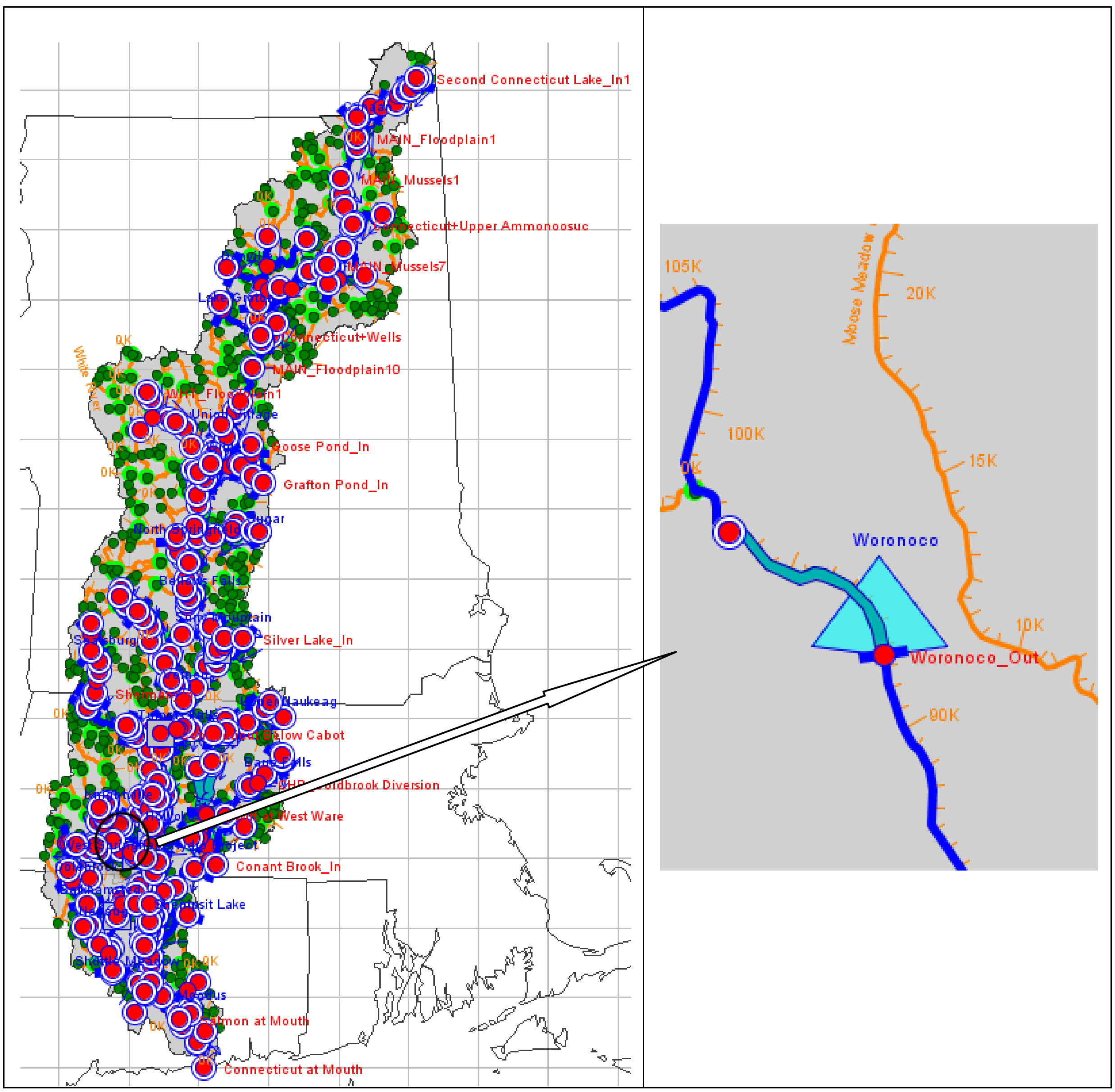


Figure 1: HEC-ResSim Map Display Showing Location of Woronco Dam

Figure 2: Photo of Woronoco dam

II. Physical Characteristics

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model. The elevation-storage-area defines the pool as shown in Figure 3[114]. The dam consists of two types of outlets: (1) uncontrolled outlet and (3) power plant as shown in Figure 4[115]. The capacity of the power plant was made to be the maximum release specified in the NID database so that the dam would modeled completely as run-of-river with some actual physical information.

[114] National Inventory of Dams database (NID)
[115] http://www.swiftriverhydro.com/Woronoco%20Hydro.htm

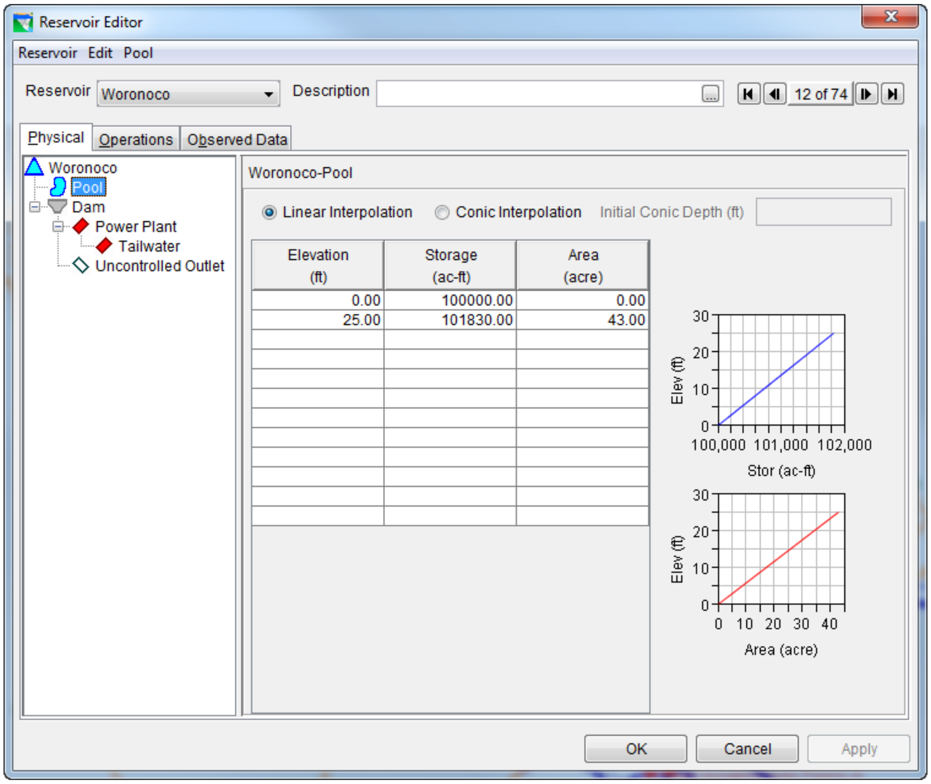


Figure 3: Reservoir Editor: Physical Tab – Pool

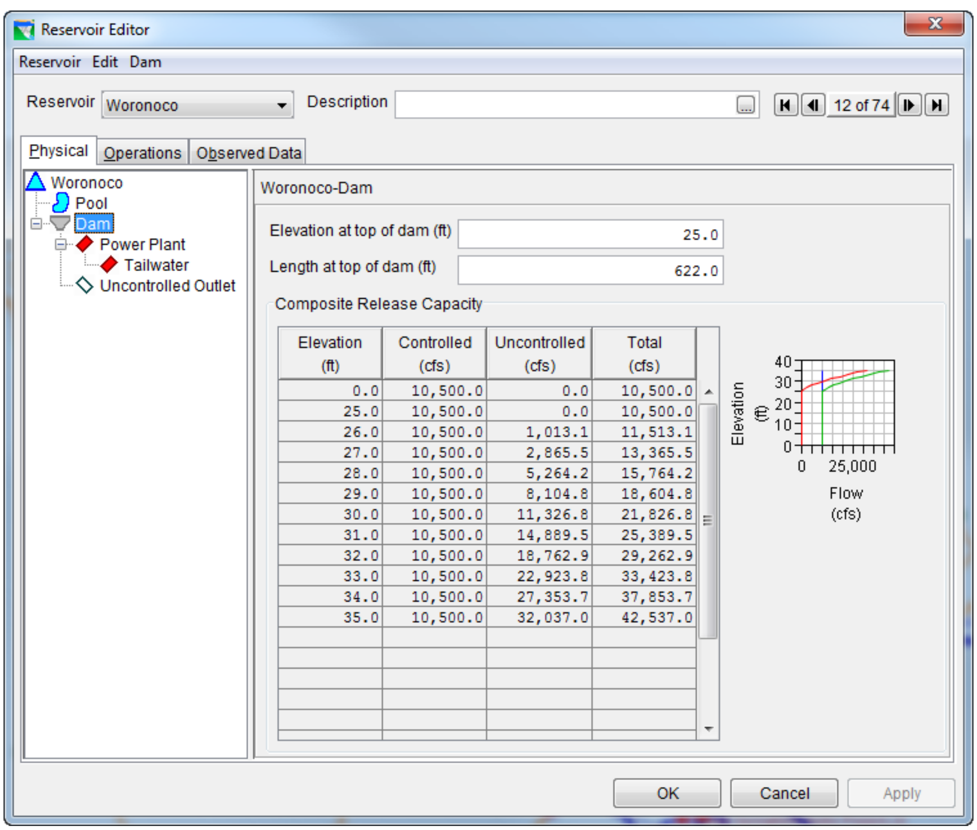


Figure 4: Reservoir Editor: Physical Tab -- Dam

III. Operations

A. Operation Set

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 5 shows the definition of Woronco's "Guide Curve" operational zones, which consist of Top of Dam (25 ft), Conservation (24.9 ft), and Inactive zone (15 ft)[1].

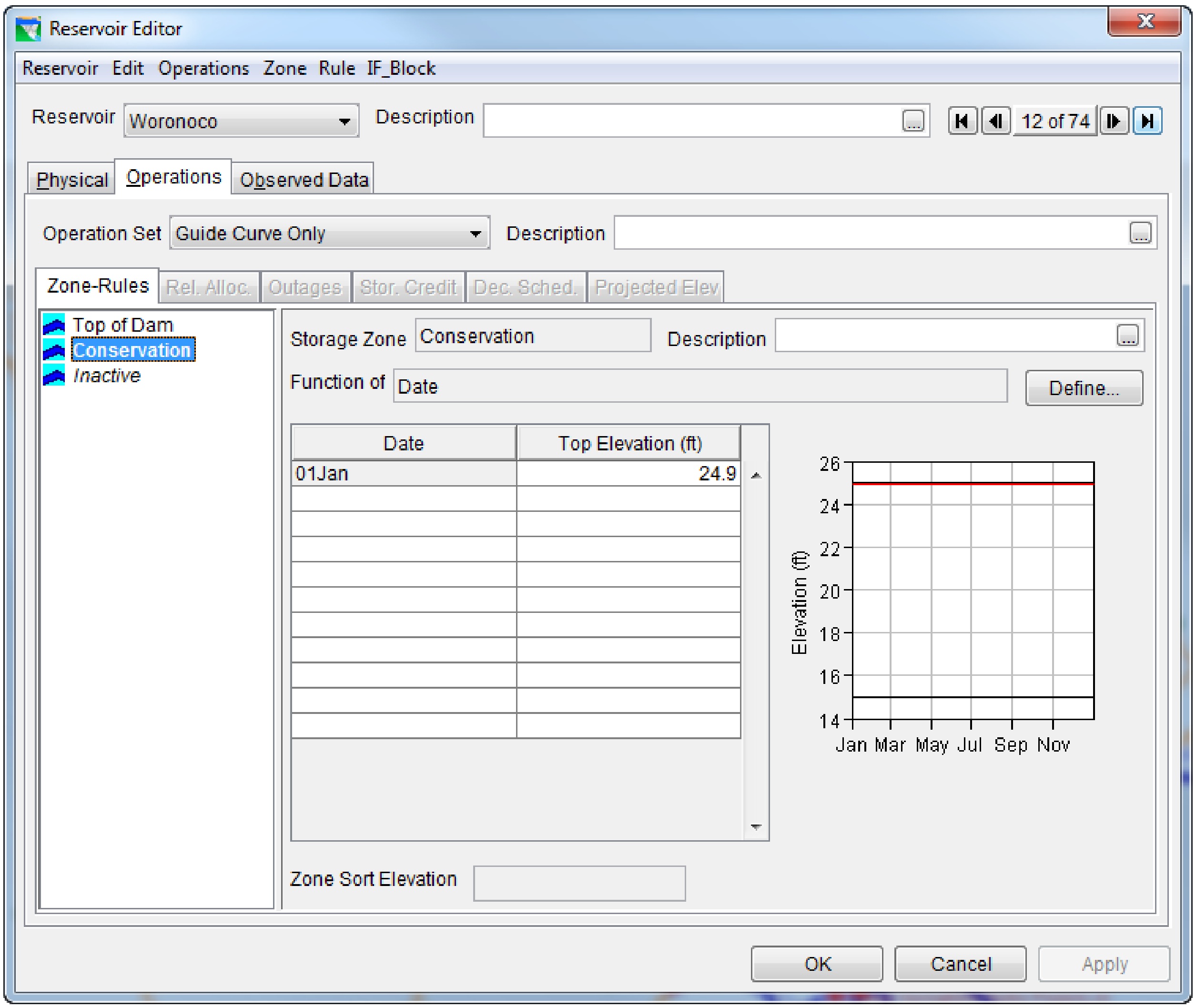


Figure 5: Reservoir Editor: Operations Tab –Guide Curve OpSet – Guide Curve

B. Rule Illustrations

The operation set for Woronco has no rules of operation making it a flow through reservoir. The pool elevation will remain at the top of conservation unless the inflow exceeds the total release capacity. This was modeled this way because no real operation information was found.